UMCES

UNIVERSITY OF MARYLAND CENTER for ENVIRONMENTAL SCIENCE

CHESAPEAKE BAY:
WATER QUALITY MONITORING PROGRAM
ECOSYSTEMS PROCESSES COMPONENT (EPC)

QUALITY ASSURANCE PLAN
FY2004

JULY 2003 - JUNE 2004

A Program Supported by the
Department of Natural Resources
State of Maryland

Ref. No. [UMCES]CBL 03-135

Maryland Chesapeake Bay Water Quality Monitoring Program

Ecosystem Processes Component (EPC)

Quality Assurance Project Plan for Water Quality Monitoring in Chesapeake Bay for FY 2004

Prepared by:
F.M. Rohland
W.R. Boynton
R.M. Stankelis
P. Smail
E.M. Bailey

Report prepared for:
Maryland Department of Natural Resources
Resource Assessment Administation
Tidewater Ecosystems Assessment Division
Tawes State Office Building, D-2
580 Taylor Avenue
Annapolis, MD 20401

July 2003 - June 2004

Approvals: **Date**

Walter R. Boynton, Principal Investigator[1] _____

Mr. Bruce Michael, Project Officer, MD DNR _____

[1]University of Maryland Center for Environmental Science
Chesapeake Biological Laboratory
P.O. Box 38, Solomons, MD 20688-0038

Technical Report Series No. TS-408-03-CBL

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED):

TABLE OF CONTENTS (CONTINUED):

Page

10. Appendices (Continued)

APPENDIX A: EPC PARAMETERS: (Continued)

APPENDIX B: SAMPLE DATA SHEETS:

APPENDIX C: SAMPLES PRINT OUT FROM DATA SETS:

TABLE OF CONTENTS (CONTINUED):

Page

10. Appendices (Continued)

APPENDIX C: SAMPLES PRINT OUT FROM DATA SETS: (CONTINUED)

APPENDIX D: DATA ERROR CODES

APPENDIX E: CONTINUOUS MONITORING PROCEDURES

From: Michael et al. (2003) QAPP DNR: Shallow Water Quality Monitoring Program, April 1, 2003 – June 30, 2004 (Appendix 1, Appendix 2, Appendix 3, Appendix 4).

LIST OF PREPARERS

Editors:

F.M. Rohland, Data Manager, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038.

W.R. Boynton, Principal Investigator, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038.

Contributors:

R.M. Stankelis, Senior Faculty Research Assistant, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038.

P. Smail, Faculty Research Assistant, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038.

E.M. Bailey, Faculty Research Assistant, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038.

Carl Zimmerman, Nutrient Analytical Services Laboratory, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038.

LIST OF FIGURES :

LIST OF TABLES:

ACRONYMS AND ABBREVIATIONS

AA	autoanalyzer
C	carbon
CBP	EPA's Chesapeake Bay Program
CBL	University of Maryland's Chesapeake Biological Laboratory
CBL	Chesapeake Biological Laboratory
cm	centimeter
DGPS	Differential Global Positioning System
DHMH	Maryland Department of Health and Mental Hygiene
DNR	Maryland Department of Natural Resources
DI	de-ionized
DIP (or PO_4^{-3})	Dissolved inorganic phosphorus
DO	Dissolved Oxygen
DOC	Ddissolved organic carbon
EPA	U.S. Environmental Protection Agency
EPC	Ecosystem Processes Component
g	gram
ICES	International Council for the Exploration of the Sea
KCl	Potassium chloride
Kd	Water column light attenuation
L	liter
m	meters
MDE	Maryland Department of the Environment, Annapolis, MD
min.	minute
mg	milligram
ml	milliliter
mm	millimeter
µg	micrograms
N	nitrogen
NASL	Nutrient Analytical Services Laboratory
NH_4^+	Ammonium
NIST	National Institute of Science and Technology
NO_2^-	Nitrite
$NO_2^- + NO_3^-$	Nitrite plus nitrate
nm	nanometer
no	number
NTU	nephalometric turbidity unit
OD	optical density
ODU	Old Dominion University
P	phosphorus
PAR	Photosynthetically Active Radiation
PC	Particulate carbon
PI	Principal Investigator
PN	Particulate nitrogen
PP	Particulate phosphorus

PO_4^{-3}	Dissolved inorganic phosphorus
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RFO	Research Fleet Operations
R/V	research vessel
SAS	Statistical Analysis System
Si	silica
SAV	Submerged aquatic vegetation
SONE	Sediment Oxygen and Nutrient Exchanges
TDN	total dissolved nitrogen
TDP	total dissolved phosphorus
TSS	seston (total suspended solids)
USDI	U.S. Department of the Interior
USGS	U.S. Geological Survey
VIMS	Virginia Institute of Marine Science
YSI	Yellow Springs Instrument
VFX	Vertical Flux Array
VSS	Volatile suspended solids
°C	degrees Celsius

1. INTRODUCTION

1.1 Project Description

During the middle decades of the twentieth century a considerable number of environmental measurements were made at a number of locations in Chesapeake Bay and its tributary rivers. Measurements included physical, chemical and limited biological variables and from these early measurements a considerable increase in understanding of estuarine physics, chemistry and biology was achieved. However, these measurements were not made in a consistent fashion and, as a result, were of limited utility in some applications. For example, dissolved nutrient measurements may have been made at a series of sites in the Patuxent River for a year or more and then efforts were relocated to a few sites in the mainstem bay. At some later time nutrient measurements were again made in the Patuxent but at different stations and at different times of the year using different sampling and analytical methodologies. A review of water quality measurements made in the Patuxent from the late 1930's until 1978 identified 44 separate studies, most of which were of too short a duration or at so limited a number of stations that detection of trends was not possible (Mihursky and Boynton, 1978). Similar problems were evident in other areas of the Bay and tributaries as well. Following completion of the first EPA Chesapeake Bay Program this serious limitation was clearly identified and a strong recommendation emerged to develop a long-term water quality monitoring program that would be capable of accurately assessing the current status of the Bay and be useful in detecting trends resulting from human activities. It was recognized that long-term measurements were needed to overcome the expected year-to-year variability due to climate variability and to ultimately assess changes due to both deleterious human activities and restoration efforts by management.

This Quality Assurance Project Plan (QAPP) describes the implementation of one component of the Maryland portion of the EPA Chesapeake Bay monitoring program described in *Chesapeake Bay: A Framework for Action* (EPA, 1983). This portion of the program is known as the "Ecosystem Processes Component (EPC)." The EPC has focused monitoring efforts in three areas including: (1) measurements of sediment influences on water column water quality; (2) description of water quality in shallow water zones of tributary rivers; and (3) monitoring epiphytic growth on seagrass leaves. Details concerning objectives and methodologies used in the EPC are contained in this report.

1.2 Objectives

The Chesapeake Bay Water Quality Monitoring Program was initiated to provide guidelines for restoration, protection and future use of the mainstem estuary and its tributaries and to provide evaluations of implemented management actions directed towards alleviating some critical pollution problems. A description of the complete monitoring program is provided in Magnien *et al.* (1987) and the Chesapeake Bay program web page (*http://www.chesapeakebay.net* and *http://www.dnr.state.md.us/bay/monitoring/eco/index.html*). In addition to the EPC program portion, the monitoring program also has components that measure:

- Freshwater, nutrient and other pollutant input rates,
- chemical and physical properties of the water column,
- toxicant levels in sediments and organisms,
- phytoplankton and zooplankton community characteristics (abundances, biomass and primary production rates) and
- benthic community characteristics (abundances and biomass).

While early work of the EPC focused primarily on the importance of fluxes across the sediment-water interface and the dynamics of these interactions, the program has grown and diversified since that time. It continues to diversify its research to better meet the changing goals of the monitoring program (Boynton *et al.*, 1997, 1998, 1999, 2000, 2001, 2002). This has involved expansion of some program elements and the discontinuation of others as well as the development of tools that improve monitoring capabilities. Several years ago, EPC developed techniques to spatially evaluate sediment water fluxes in a more cost effective manner. More recently evaluation of near-shore water quality conditions relative to submerged vegetation (SAV) and SAV epiphytic growth have become an important portion of the program. Three years ago, EPC developed continuous surface water quality mapping techniques for the program. The design of this equipment has recently been updated. Additional, smaller elements, are occasionally added to the EPC program to collect small data sets for specific purposes (*e.g.* grain size of sediments).

The current program is composed of the following complimentary study elements:

- **Submerged aquatic vegetation (SAV) habitat and restoration evaluation:** SAV transplants, water quality conditions, and epiphyte accumulation rates will be measured at two locations on the Patuxent River in the latter half of 2003 and first half of 2004. Experiments will be conducted to evaluate the effectiveness of various SAV grazer exclusion designs.

- **Spatially Intensive Water Quality Monitoring (DATAFLOW):** Water quality mapping using the DATAFLOW V surface water quality mapping system. This effort will provide estimates of surface water quality parameters (salinity, water temperature, dissolved oxygen, fluorescence and turbidity) and total depth at high spatial resolution (1 sample per 50-100m). Spatially intensive water quality mapping of surface waters in the Patuxent River will be conducted approximately monthly from July through October 2003 and April though June 2004.

- **Continuous Water Quality Monitoring:** High frequency measurements of various water quality parameters will be measured at 4 locations in the Patuxent River from July through October 2003 and April though June 2004.

- Information collected in this program is integrated with other elements of the monitoring program to gain a better understanding of the processes affecting water quality of the Chesapeake Bay and its tributaries and the maintenance and restoration of living resources.

1.3 Sampling Design and Data Quality Objectives

1.3.1 Submerged Aquatic Vegetation (SAV) Habitat Evaluation on Patuxent River

At 2 locations in the Patuxent River (Figure 1-1), a full suite of water quality parameters (Table 1-1) will be measured approximately bi-weekly from July – October 2003 and April – June 2004. Epiphyte fouling rates will be measured for 3 consecutive weeks each in the, summer and fall of 2003 and the spring of 2004

1.3.2 Spatially Intensive Water Quality Mapping: DATAFLOW V Mapping System

The sponsor (MD DNR) selected the Patuxent River for continuous surface water quality mapping operations. Each mapping cruise in the Patuxent River will follow an approximate square wave pattern frequently traversing from shallow waters (as shallow as can be navigated in safety) out to channel depths, along the channel, back into shallow waters, paralleling the shoreline, then back to the channel. Due to the likely presence of many navigational hazards and limitations due to sea conditions, the actual cruise track will be determined on the day of operation. A total of 14 mapping cruises will be completed in this tributary systems approximately biweekly from July through October 2001 and April through June 2003.

The purpose of DATAFLOW is to assess the spatial variability in water quality. The spatial resolution of the data collected depends on the speed and cruise track of the vessel. However, both are constrained by time and funds available to perform a practical assessment. It has been shown (EPC Interpretive #19, Boynton *et al.*, 2002) spatially intensive sampling can uncover patterns in water quality that are missed by single fixed station monitoring. The purpose of the calibration stations is to correlate DATAFLOW sensor output to universally measured parameters (Kd, secchi) and laboratory derived results (TSS, Chlorophyll-*a*) collected simultaneously. The goal of high frequency buoys is to temporally characterize water quality patterns at a particular location rather than spatial characterization. The data collected by a buoy would essentially be similar to the data collected by DATAFLOW at a single moment in time. Correlation to laboratory values or universally measured parameters would still be required.

1.3.2.1 Dataflow Calibration Stations

In addition to the high-resolution data collected by DATAFLOW V, additional calibration data will be collected at 8 locations within the tributary. Two calibration stations within the tributary will also coincide with locations of DNR high-frequency data collection. The remaining sites will be selected to represent a large signal range needed for sensor calibration. At these locations, water samples will be collected for the analysis of dissolved nutrient concentrations, chlorophyll-*a* (active and total), phaeophytin, total suspended solids and volatile suspended solids. Measurements of PAR will be made to calculate water column light attenuation (Kd). Secchi depth measurements will be taken.

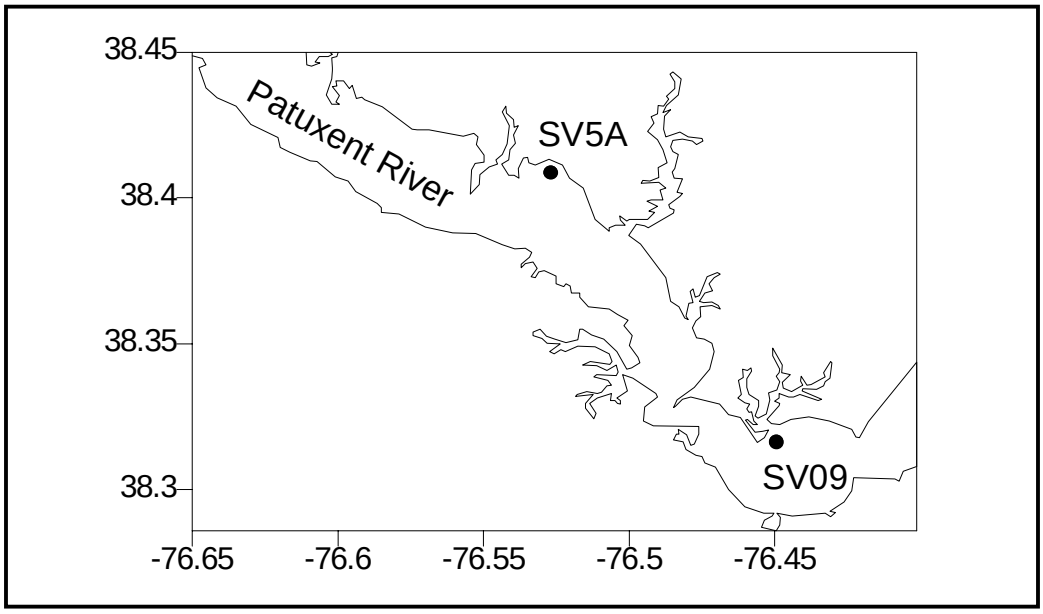

Figure 1-1. Locations of SAV habitat and restoration activities in 2003 and 2004.

Table 1-1. Description of variables to be measured as part of the SAV habitat evaluation and spatially intensive water quality mapping.
Variable abbreviations shown below are as follows: DIN = dissolved inorganic nitrogen, DIP = dissolved inorganic phosphorus, Chl*a* = chlorophyll-*a*, TSS = total suspended solids, DO = dissolved oxygen, Kd (PAR) = light attenuation coefficient for photosynthetically active radiation, Temp = temperature, Cond = conductivity, VSS = total volatile solids, TDN=total dissolved nitrogen, TDP=total dissolved phosphorus, and DOC=total organic carbon.

SAV habitat evaluation Component	Location No Stations	Sampling frequency (Approximate schedule)	Variables measured SAV and Spatially Intensive Water Quality Mapping
Near shore water quality	Patuxent River: 2 sites	bi-weekly: July – Oct. 2003 bi-weekly: April – June 2004	Water column: DIN, DIP, Chl*a*, TSS/VVS, DO, Kd(PAR), Temp, salinity, cond., secchi, TDN, TDP, DOC
SAV Epiphyte study	Patuxent River: 2 sites	3 Weekly rate measurements, summer, and fall 2003, spring 2004	Epiphyte: Chl*a*, TSS/VSS
SAV transplant evaluation	Patuxent River: 2 sites	Monthly qualitative evaluation Seasonal quantitative assessment	General health Shoot density, % cover or other appropriate measures

2. MEASURED PARAMETERS

Some parameters — conductivity, salinity, temperature, dissolved oxygen, Secchi depth — are measured *in situ*. The other measured parameters — including nitrogen, phosphorus, carbon, total suspended solids and chlorophyll-*a* are determined in the laboratory. Tables 2-1 and 2-2 list the parameters measured, the detection limits and method references. Details of sample collection, sample processing and storage, and analytical procedures are described in Appendix A.

Table 2-1. A Summary of Field Parameters, Method Reference and Performance Criteria.

Matrix	**Parameter (Units)**	**Method Reference - Field**	**Minimum Detection Limit**	**Holding Time and Condition**
Water	Temperature (C)	Probe WTEMPF01: p. *A-xxxvii*	0.1 C	*In situ*
Water	Depth - Station (m)	Calibrated Depth Pole SAMDF04: p. *A-x* Garmin GPS/Sounder 185 TOTDF01: p. *A xi*	0.1m 0.3m	*In situ*
Water	Dissolved Oxygen (mg l^{-1})	Probe DOF01: p. *A-xv*	0.3 mg l^{-1}	*In situ*
Water	Conductivity (mS cm^{-1})*	Probe CONDF01: p. *A-ix* COND06: p. *A-ix*	1 mS cm^{-1}	*In situ*
Water	Salinity (psu)	Probe SALINITYF04: p. *A-xxxiv*	0 psu	*In situ*
Water	Secchi depth (m)	Disk 25.5 cm diameter SECCIF01: p. *A-xxxv*	0.1 m	*In situ*
Water	PH	Probe TBD: *p: A-xxx*	0 (su)	*In situ*
Water	Photosynthetically Active Radiation (µE or µM m^{-2} sec^{-1})	*Li-cor* Li-192SA, Li-190SA on board sensor TBD: p. *A-xxxiii*	0.1 µE (or 0.1 µM m^{-2} sec^{-1})	*In situ*
Water	Chlorophyll-*a* (%FS)	6025 Chlorophyll Probe FLURF01: p. *A-viii*	0 %	*In situ*
Water	Turbidity (NTU)	Probe TURB: p. *A-xlviii*	0.1 NTU	*In situ*

* mS cm^{-1} (European measurement) = 1 mmho cm^{-1} (European and USA equivalent)

Table 2-2. A Summary of Analytical (Laboratory) Parameters, Method Reference and Performance Criteria.

Matrix	Parameter (Units)	Method Reference - Analytical	MDL***	Precision (% CV)*	Accuracy (percent spike recovery)
Water	Ammonium (µM)	Berthelot Reaction NH4FL01: p. *A-i*	0.0030 µM	< 5%	90-110%
Epiphyte	Active Chlorophyll-*a*	Flourescence after acidification SDCHAA19: p. *A-iii*	0.60 µg l^{-1}	—	—
Epiphyte	Total Chlorophyll-*a*	Flourescence before acidification SDCHTA18: p. *A-v*	0.51 µg l^{-1}	—	—
Water	Dissolved Organic Carbon	Shimadzu TOC-500 TBD: p. *A-xi*	0.15 µM	< 10%	90 – 110 %
Water	Dissolved Inorganic Phosphorus (µM)	Antimony-phospho-molybdate complex PO4FL01: p. *A-xiii*	0.0007 µM	< 5%	90-110%
Water	Nitrite (µM)	Diazo compound NO2FL01 p. *A-xviii*	0.0003 µM	< 5%	90-110%
Water	Nitrate + Nitrate (µM)	Copper-cadmium reduction NO23FL01: p. *A-xx*	0.0007 µM	< 5%	90-110%
Water	Particulate carbon	EPA 440.0 PCA08: p. *A-xxii*	6.32 µM	—	—
Water	Particulate nitrogen	EPA 440.0 PNA09: p. *A-xxiv*	0.88 µM	—	—
Water	Particulate phosphorus	Phosphomolybdate blue PPA10: p. *A-xxvi*	0.08 µM	—	—
Water	Particulate inorganic phosphorus	Phosphomolybdate blue TBD: p. *A-xxviii*	0.08 µM	—	—
Epiphyte	Phaeophytin	Flourescence after acidification PHEOL01: p. *A-xxxi*	0.48 µg l^{-1}	—	—
Water/ Epiphyte	Seston (mg l^{-1})	Retention on standard glass filter pad TSSL01: p. *A-xliii*	2.4 mg l^{-1}	< 10%	—
Water	Silicate	Silicomolybdate SIOH4A07: p. *A-xxxvi*	0.37 µM	< 10%	90 – 110 %
Water	Total Dissolved Nitrogen	Persulphate oxidation TDNA04: p. *A-xxxix*	2.1 µM	< 10%	90 – 110 %
Water	Total Dissolved Phosphorus	Persulphate oxidation TDPA06: p. *A-xli*	0.05 µM	< 10%	90 – 110 %
Water/ Epiphtye	Volatile Suspended Solids (mg l^{-1})	Retention on standard glass filter pad + combustion + weight by difference TVSA13: p. *A-xilv*	0.9 mg l^{-1}	< 10%	—

* Concentration dependent

** BCSS-1

*** MDL Method Detection Limit as on May 30, 2003.

Note: In the laboratory seven replicates were used.
No replicates were used in the field.

Table 2-3. Shallow Water Monitoring Program Grab Sample Water Column Parameters, Detection Limits, Methods References, and Holding Times and Conditions.
From: Michael et al. (2003) QAPP DNR: Shallow Water Quality Monitoring Program, April 1, 2003 – June 30, 2004 (Draft, page 5).

Parameter (Units)	Detection Limit (or Range)	Method Reference	Holding Time and Condition
GRAB SAMPLES			
Parameter (Units)	**Detection Limit (or Range)**	**Method Reference**	**Holding Time and Condition**
Orthophosphate (mg L^{-1} as P)	0.0006 mg L^{-1}	EPA method 365.1 (EPA 1979)	Freezing-28 d
Total Diss. Phosphor (mg L^{-1} as P)	0.001 mg L^{-1}	Valderrama 1981	Freezing-28 d
Particulate Phosphorus (mg L^{-1} as P)	0.0024 mg L^{-1}	Aspila et al. 1976	Freezing-28 d
Nitrite (mg L^{-1} as N)	0.0002 mg L^{-1}	EPA method 353.2 (EPA 1979)	Freezing-28 d
Nitrite + Nitrate (mg L^{-1} as N)	0.0007 mg L^{-1}	EPA method 353.2 (EPA 1979)	Freezing-28 d
Ammonium (mg L^{-1} as N)	0.003 mg L^{-1}	EPA method 350.1 (EPA 1979)	Freezing-28 d
Total Dissolved Nitrogen (mg L^{-1} as N)	0.02 mg L^{-1}	D'Elia et al. 1977; Valderrama 1981	Freezing-28 d
Particulate Nitrogen (mg L^{-1} as N)	0.0105 mg L^{-1}	EPA method 440.0 (EPA 1997)	Freezing-28 d
Diss. Organic Carbon (mg L^{-1} as C)	0.24 mg L^{-1}	Sugimura and Suzuki (1988)	Freezing-28 d
Particulate Carbon (mg L^{-1} as C)	0.0633 mg L^{-1}	EPA method 440.0 (EPA 1997)	Freezing-28 d
Silicic Acid (mg L^{-1}as Si)	0.01 mg L^{-1}	Technicon (1977)	4 °C - 28 d
Total Suspended Solids (mg L^{-1})	2.4 mg L^{-1}	EPA method 160.2 (with slight modification) (EPA 1979; APHA 1975).	Freezing-28 d
Chlorophyll *a* (μg L^{-1})	0.1 μg L^{-1}	APHA (1981)	Freezing-28 d
Pheophytin *a* (μg L^{-1})	0.1 μg L^{-1}	APHA (1981)	Freezing-28 d

REFERENCES for Table 2:

American Public Health Association (APHA). 1981. Method 1002 G, chlorophyll (trichromatic), in *Standard Methods for the Examination of Water and Wastewater*, 17th ed.

American Public Health Association (APHA). 1975. Method 208D, total nonfilterable residue dried at 103-105°C (total suspended matter), in *Standard Methods for the Examination of Water and Wastewater*, 14th Edition. APHA: Washington, D.C. 1193 p.

Aspila, I., H. Agemian and A. S. Y. Chau. 1976. A semi-automated method for the determination of inorganic, organic and total phosphate in sediments. *Analyst* 101:187-197.

D'Elia, C. F., P. A. Steudler and N. Corwin. 1977. Determination of total nitrogen in aqueous samples using persulfate digestion. *Limnol. Oceanogr*. 22:760-764.

***Hydrolab System Water Quality Instrumentation Manual* (HSWQIM).** 1984-1998 (multiple editions). Published by Hydrolab Corporation, P.O. Box 50116, Austin, Texas.

Parsons, T.R., Takahashi, M. and B. Hargrave. 1977. *Biological Oceanographic Processes*. Pergammon Press. Oxford. 332 p. (pages 71-85).

Smith, R. C. 1969. An underwater spectral irradiance collector. *J. Mar. Res*. Vol. 27: 341-351.

Sugimura, Y. and Y. Suzuki. 1988. A high temperature catalytic oxidation method for the determination of non-volatile dissolved organic carbon in seawater by direct injection of a liquid sample. *Mar. Chem*. 24:105 - 131.

Technicon Industrial Systems. 1977. Industrial Method No. 186-72W/B, in *Silicates in Water and Seawater*. Technicon Industrial Systems: Tarrytown, NY.

US Environmental Protection Agency (EPA). 1997. *US EP A Method 440.0. Determination of Carbon and Nitrogen in Sediments and Particulates of Estuarine/Coastal Waters Using Elemental Analysis.* Revision 1.4. National Exposure Research Laboratory, Office of Research and Development, US Environmental Protection Agency: Cincinnati, OH.

US Environmental Protection Agency (EPA). 1979. *Methods for Chemical Analysis of Water and Wastes*. EPA-600/4-79-020. 460 p.

Valderrama, J. C. 1981. The simultaneous analysis of total nitrogen and total phosphorus in natural waters. *Mar. Chem*. 10:109-122.

Welch, P.S. 1948. Chapter 11 in *Limnological Methods*. Blakiston: Philadelphia, PA. pp. 159-167.

3. FIELD MEASUREMENTS AND SAMPLING

3.1 Submerged Aquatic Vegetation (SAV) Near-Shore Habitat Evaluation

3.1.1 SAV Water Quality Field Methods

At each of the near-shore stations, water quality parameters were measured at 0.5 meters below the water surface. This water depth roughly corresponds to mid-water column depth at each of the near-shore stations where total water depth was approximately 1 meter mean low water. Water column physical parameters and water column nutrients were measured at this depth.

3.1.2 Physical Parameters

Temperature, salinity, conductivity, and dissolved oxygen measurements were collected with a Yellow Springs International (YSI) 600R, YSI 6920 or YSI 6600 multi-parameter water quality monitor. Water column turbidity was estimated with a secchi disk, while water column light flux in the photosynthetically active frequency range (PAR) was measured with a *Li-Cor* LI-192SA underwater quantum sensor. Light flux measurements were collected at three discrete water depths in order to calculate water column light attenuation (Kd). Weather and sea-state conditions such as air temperature, percent cloud cover, wind speed and direction, total water depth, and wave height were also recorded.

3.1.3 Water Column Nutrients

Whole water samples were collected in polyethylene jugs with a hand pump, and a portion immediately filtered with a 25 mm, 0.7 µm (GF/F) glass fiber filter. Both the filtered portion and the remaining whole water samples were placed in coolers for transport back to the laboratory for further processing. The filtered portion was analyzed by the NASL for ammonium (NH_4^+), nitrate (NO_2^-), nitrite plus nitrate ($NO_2^- + NO_3^-$) and phosphate (PO_4^{-3}). Whole water portions were filtered in the laboratory using 47 mm 0.7 µm (GF/F) glass fiber filters and were analyzed by NASL for the following particulate nutrients: volatile suspended solids (VSS), and total and active chlorophyll-*a* concentrations where total chlorophyll-a includes chlorophyll-*a* plus breakdown products. On each dataflow cruise water samples are collected at 8 stations and analyzed for chlorophyll-*a*, TSS and VSS using the same methods described in Section 4.

3.2 Epiphyte Growth Measurement Method

In order to assess the light attenuation potential of epiphytic growth on the leaves of submerged aquatic vegetation (SAV), artificial substrata in the form of thin strips of Mylar® polyester plastic

were deployed at each of the six near-shore stations for periods of 6 - 8 days. During each cruise throughout the sampling season, replicate strips exposed to natural fouling were retrieved and new strips deployed. The use of transparent Mylar® provided a means to estimate light attenuation due to epiphytic growth and sediment accumulation, as well as to quantify the organic and inorganic components of the fouling.

3.2.1 Description of Epiphyte Collector Arrays

Each collector array (Figure 3-2.) consists of a square PVC frame situated horizontally with a vertical PVC shaft oriented in the center of the square. To this shaft is attached a line with a small surface float that allows for easy location of the collector. Each collector array holds six strips per deployment. Mylar ® strips (2.5 cm wide x 51 cm long and 0.7 mil thick) are attached to the frame so that the top is allowed to move freely in the water column. Small foam floats (~3.5 x 3.3 cm) are attached to the top of the strip to help maintain a vertical position in the water column at all times.

3.2.2 Sampling the Epiphyte Collector Arrays

To retrieve the epiphyte collector strips, each collector array is gently removed from the water and suspended from the gunwale of the vessel. A single representative Mylar® strip is removed each for chlorophyll-*a* and VSS analysis. The pre-marked 5 inch center section of each strip is cut into smaller pieces and placed in a 60ml centrifuge tube. The tubes are placed in an ice filled cooler for transport back to the laboratory. Upon arrival at the laboratory, the tubes are immediately frozen and transferred to NASL for further processing. The variation in epiphyte accumulation on Mylar strips within a single site for a single deployment is quite small but depends on the location being monitored. Maximum % standard error (%SE) among strips is ±25% total accumulation for both epiphyte chlorophyll-*a* or epiphyte dry mass.

3.2.3 Processing Total Epiphyte Material

Sections of Mylar® strips collected for TSS/VSS analysis are scraped of all material and rinsed with distilled water and diluted to a fixed volume (400 - 500 ml). The solution is mixed as thoroughly as possible on a stir plate until homogenized. A small aliquot (10 to 50 ml) is then extracted with a glass pipette and filtered through a 47 mm 0.7 µm (GF/F) glass fiber filter. Once filtered, the pads were immediately frozen and delivered to NASL for analysis.

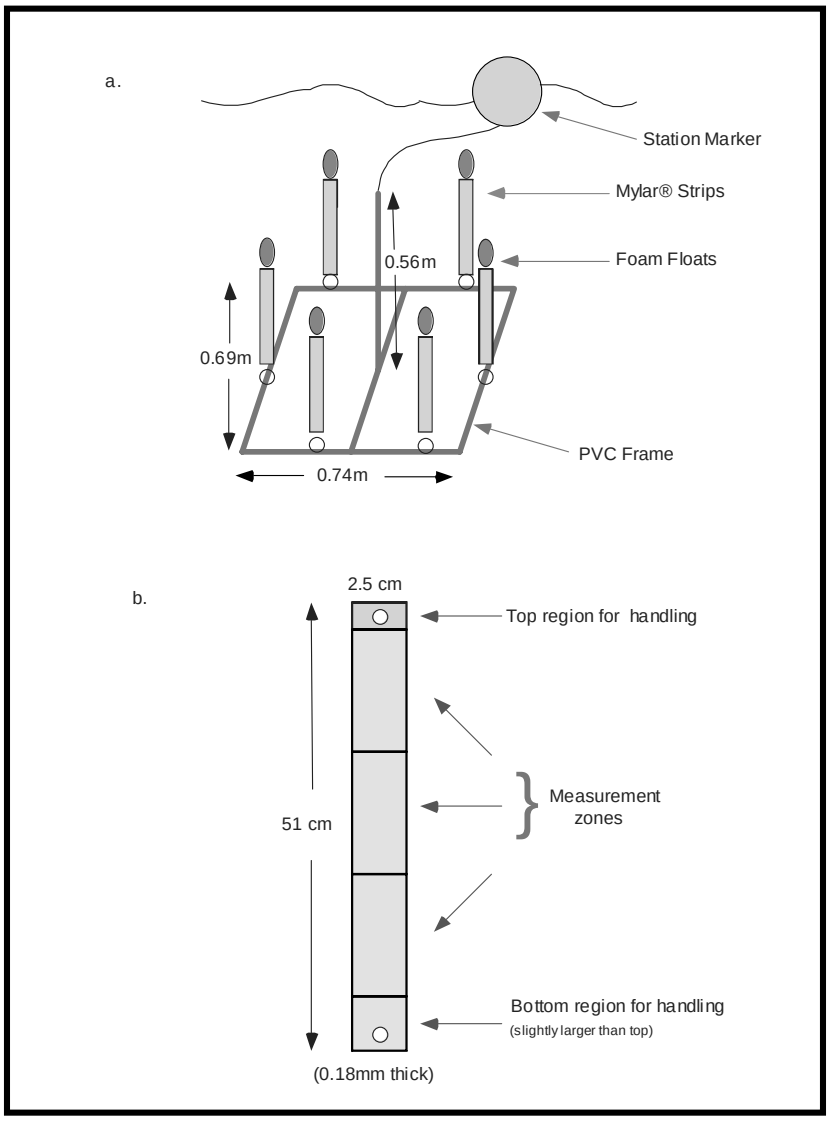

Figure 3-1. Diagram of SAV Epiphyte Collector Array.
a. Epiphyte Collector Array
b. Mylar® strips

3.3 Spatially Intensive Water Quality Mapping: DATAFLOW V Mapping System

DATAFLOW V is a compact, self-contained surface water quality mapping system, suitable for use in a small boat operating a planing speeds of about 25 KT. The system collects water through a pipe ("ram") deployed on the transom of the vessel, pumps it through an array of water quality sensors, then discharges the water overboard.

3.3.1 Water Quality Instrumentation

DATAFLOW V (Figure 3-3) has a YSI 6600 Sonde equipped with a flow through chamber. The sensors include a Clark-type YSI 6562 DO probe, a YSI 6560 conductivity/temperature probe, a 6026 turbidity probe, and a 6025 chlorophyll probe. The sonde transmits data collected from the sensors to a YSI 650 data logger. On each dataflow cruise water samples are collected at 8 stations and analyzed for chlorophyll-*a*, TSS and VSS using the same methods described in Section 4.

3.3.2 Positioning and Depth Information

DATAFLOW V is equipped with a hand-held Garmin e-Trex global positioning system and a Garmin 168 global positioning system with a built in depth sounder. The Garmin e-Trex GPS transmits position data to the YSI 650 data logger through a NMEA 0183 version 2.0 data format. The data logger matches the position data with sensor data for each observation. Positioning errors are expected to be less than 15 m. The Garmin 168 GPS transmits NMEA data to a Procomm Plus communication program running on a Wescor RDT 3200 portable computer. The data is transmitted in a NMEA 0183 version 2.3 data format. The data is then processed through a Perl program. This removes time, position, and depth data. The depth data is then merged with the data collected from the YSI 650 data logger through a SAS program and then put into an Excel file.

3.3.3 Flow Meter

DATAFLOW V is equipped with an inline flow meter. Although the flow rate does not affect any of the sensor readings, decreased flow is an indication of either a partial blockage or an interruption of water flow to the instrument. Thus, the flow data is used in the field as a diagnostic tool to ensure that the instrument is working properly and later as a quality assurance tool, to verify that water flow was uninterrupted. A boat horn is wired to the flow meter. If the flow is interrupted and the flow rate falls below 3.0 l s^{-1}, the horn sounds and warns the operators that a problem must be corrected.

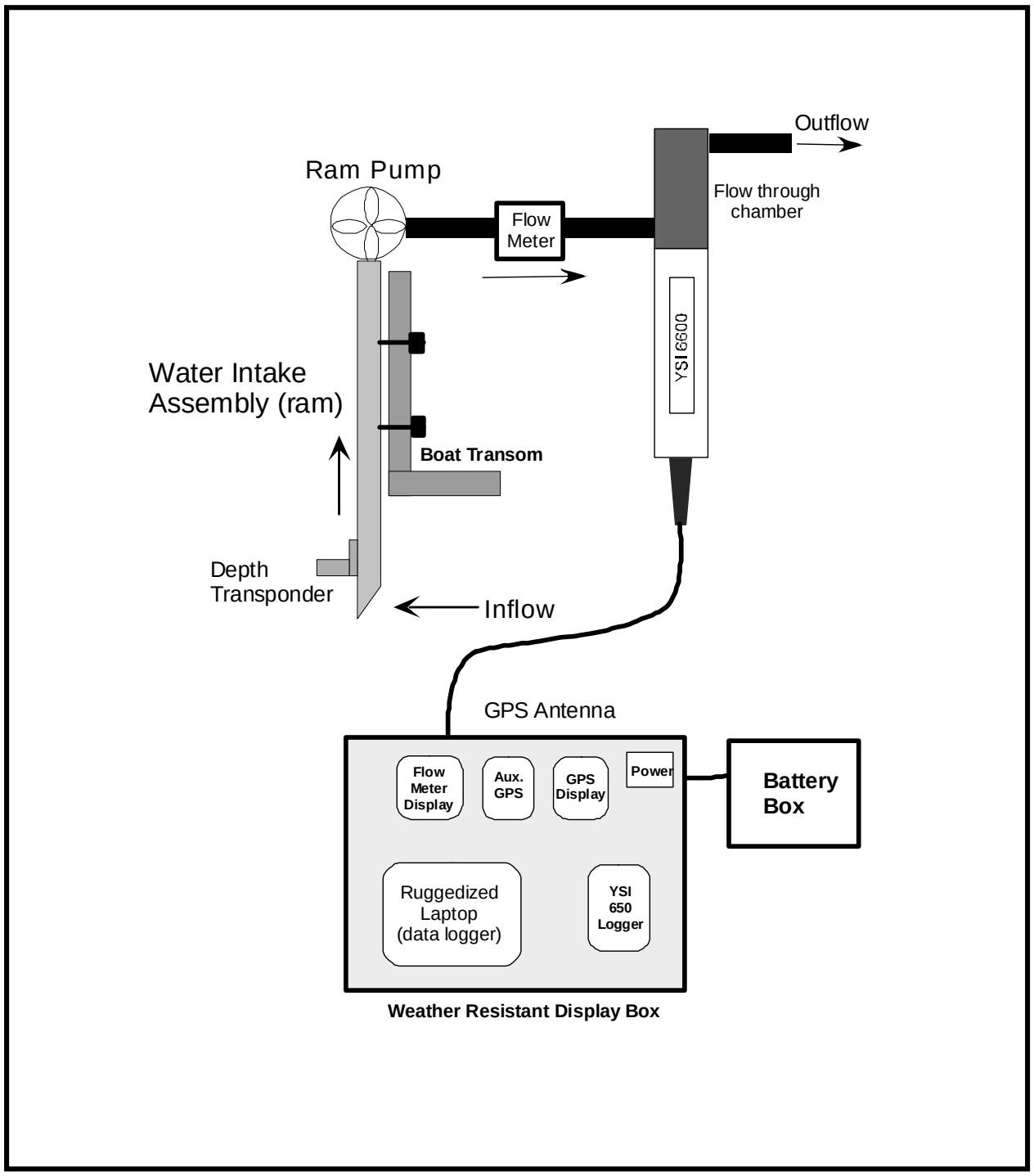

Figure 3-3. Schematic diagram of DATAFLOW V illustrating the path of water through the instrument. *Seawater is picked up behind the transom of the research vessel through the "ram." A centrifugal pump mounted on the ram ("ram pump") pulls up the seawater. The water runs through a flow meter that is wired to a horn that sounds if the flow rate falls below 3 l s^{-1}. If flow is interrupted during sampling, the horn sounds informing operators that a problem exists. The water exits the flow meter and enters the YSI flow-through chamber. The water runs across the sensor probes and exits the flow-through chamber before being discharged overboard. The displays for the YSI 650 data logger, Garmin 168 GPS, Garmin e-Trex GPS, flow meter display, and RDT 3200 are located on the instrument platform.*

3.4. Continuous Water Quality Monitoring

From: Michael et al. (2003) QAPP DNR: Shallow Water Quality Monitoring Program, April 1, 2003 – June 30, 2004 (Draft, page 7).

Each continuous monitor records seven water quality parameters every 15 minutes. The seven water quality parameters measured are water temperature, salinity, dissolved oxygen concentration, dissolved oxygen saturation, turbidity (NTU), fluorescence (used to estimate chlorophyll *a*) and pH. Meters are located at a constant depth of one meter below the surface of the water.

Each monitoring station is equipped with a YSI 6600 Sonde. The Sonde transmits the data from the sensors to a YSI 650 data logger. Meters are suspended from a float inside of PVC pipes with three-inch holes drilled along their length to allow for water exchange.

In addition to the parameters measured by the Sonde, Secchi depth and light attenuation are measured weekly from May to October, and grab samples are taken. See Appendix E-2 for a description of the filtering procedures. The processed samples are sent to Chesapeake Biological Laboratory for analysis. These results are used to calibrate the meters and to check the YSI data for accuracy. The samples are also analyzed for chemical parameters that cannot be observed by the YSI meters. Parameters analyzed at the laboratory are chlorophyll *a (total and active)*, total dissolved nitrogen, particulate nitrogen, nitrite, nitrite + nitrate, ammonium, total dissolved phosphorus, particulate phosphorus, orthophosphate, dissolved organic carbon, particulate carbon, silica, total suspended solids, volatile suspended solids.

4. LABORATORY ANALYSIS

Methods for the determination of dissolved and particulate nutrients are as follows: ammonium (NH_4^+), nitrite (NO_2^-), nitrite plus nitrate ($NO_2^- + NO_3^-$), and dissolved inorganic phosphorus (DIP or PO_4^-) are measured using the automated method of EPA (1979); particulate carbon (PC) and particulate nitrogen (PN) samples are analyzed using an Elemental Analyzer; particulate phosphorus (PP) concentration is obtained by acid digestion of muffled-dry samples (Aspila *et al.*, 1976); methods of Strickland and Parsons (1972) and Parsons *et al.* (1984) are followed for chlorophyll-*a* analysis, silicate (Si), total dissolve nitrogen (TDN), total dissolved phosphorus (TDP), dissolved organic carbon (DOC) and particulate inorganic phosphorus (PIP).

All analytical (laboratory) parameters are analyzed at the University of Maryland's Chesapeake Biological Laboratory (CBL), Nutrient Analytical Services Laboratory.

5. DATA MANAGEMENT, VERIFICATION AND DOCUMENTATION

The objectives of QA/QC standards are to provide accurate measurement of water quality and SAV parameters in Patuxent River. Over the years that the EPC has been making measurements consistent protocols have been developed in the field. Together with laboratory procedures already in place and used by NASL and data management procedures, the data obtained can be analyzed and interpreted so that the final report submitted will meet the objectives stated for this study. Information derived from the report will be useful to managers making decisions concerning Patuxent River.

5.1 QA/QC Field Checks

Cruises are scheduled well ahead of time with Research Fleet Operations (RFO). A schedule for activities for each day of the individual cruises is submitted to the PI and other members of staff. Cruises that are canceled due to weather or mechanical problems with the research vessel are rescheduled.

Rather than take field duplicates, samples are collected at 8 stations to capture the variability throughout the study site. Due to tidal transport returning to the initial station would not produce comparable results: it would be equivalent to taking another calibration station.

5.2 QA/QC Continuous Water Quality Monitoring

From: Michael et al. (2003) QAPP DNR: Shallow Water Quality Monitoring Program, April 1, 2003 – June 30, 2004 (Draft page 9).

The continuous meters are retrieved, calibrated and replaced weekly from May to October and every two weeks from November to April at the year round sites. The meters are replaced with clean, recalibrated units and the stored data from the data logger are downloaded into a computer spreadsheet. These data are then subjected to quality assurance/quality control checks by field personnel ensuring that values are not out of range. For example, values below those values listed in Table 5-1 are evaluated carefully to ensure that they are real values. See Appendix E-3 for more details on the Field Staff QA/QC procedures.

Table 5-1. Values below which continuous monitoring data are carefully evaluated for validity.

Parameter	Value
Chlorophyll-*a*	5% of true value
Conductivity, specific	5% of true value
Dissolved Oxygen	0.5 mg l^{-1}
pH	0.2 pH units
Turbidity	5% of true value
Water Temperature	0.2 ºC

At the end of the monitoring season, additional data QA/QC procedures are conducted by DNR office personnel at the Tawes Office. Staff plot all the data and then thoroughly research any outliers or other odd values. For example, we compare unusual values to historic values and values elsewhere in the Bay, consider weather events, and consult with field staff regarding possible legitimate causes for those values. In cases where values are not legitimate, they are deleted from the dataset with the approval of the field staff and the Quality Assurance Officer.

5.2 Preparation of Collection Gear

During the last few days prior to initiating a research cruise all the necessary equipment involved in the collection of water and sediment samples, incubation of sediment cores and collection of physical water quality data are inventoried according to "checklists". All equipment is checked to insure that it is fully operational and has been properly cleaned. The equipment in packed into containers that provide for easy transport and loaded aboard the research vessel. The "checklist" is then re-examined to verify the presence of all necessary gear.

Standards and reagents involved in the calibration of instrumentation are made according to a schedule of shelf life (*i.e.* daily, weekly or seasonally) or if the supply is exhausted. All chemicals are handled, prepared and stored in accordance with standard laboratory practices.

Lost samples are a rarity and in those instances a code is inserted into the data to record the problems encountered (See Section 5.3.1.2). Details of sample collection are found in Appendix A.

5.2.1 Potential Contamination

During the course of a research cruise different steps are taken to insure that the chances for contamination are minimized. These practices involve almost constant washing of equipment during the course of a cruise. All containers used to collect bulk raw water are rinsed with copious amounts of sample (station) water before they are filled and are thoroughly acid washed and then rinsed with deionized water at the end of the cruise. Containers from which samples will be taken for chemical analysis are rinsed additionally with deionized water. All containers into which are placed water and sediment samples for chemical analysis (after being fully processed) are single use/disposable plastic vials and centrifuge tubes that require no cleaning. All syringes and other laboratory equipment used in processing these samples are washed with deionized water between each use. All glassware associated with the preparation of standards and reagents is cleaned with copious amounts deionized water and acid washed when appropriate.

5.2.2 Calibration Procedures and Frequency

All instruments (YSI 6920/600/6600) involved in the collection of physical water quality data (temperature, conductivity, salinity and dissolved oxygen) are calibrated weekly, with the exception of dissolved oxygen calibration, which occurs prior to each cruise and incorporates a

standard air calibration based on air temperature and barometric pressure. Conductivity/salinity is calibrated with a 0.10 molar standard of potassium chloride. Temperature is calibrated by the manufacturer only when the instrument is returned for service.

All instruments are maintained in accordance with manufacturers specifications. Standards and reagents involved in the calibration of instrumentation are made according to a schedule of shelf life *(i.e.* daily, weekly or seasonally) or if the supply is exhausted. All chemicals are handled, prepared and stored in accordance with standard laboratory practices. If any apparent problems arise the instrument is removed from use until the malfunction can be diagnosed and remedied.

All of the sensors for the continuous surface water quality mapping system must be calibrated. The conductivity sensor, water temperature sensor, dissolved oxygen sensor and transmissometer are calibrated in the laboratory again known standards. These standards are as follows:

Parameter	**Calibration Method**
Specific Conductance	10 mmol KCl
Dissolved Oxygen	Air Calibration
Tranmissometer	Turbidity Standards / Field Calibration
Fluorometer	Laboratory Standard / Field Calibration

Laboratory calibrations are performed daily for dissolved oxygen and conductivity also occasionally for transmittance and flourescence. Although laboratory air calibrations are performed for the dissolved oxygen sensor, several Winkler titrations are performed regularly to ensure proper calibration. For transmittance and fluorescence, the manufacturer recommends that the instrument be calibrated against *in-situ* properties measured in the field. A variable number of water samples are collected in a field deployment that are analyzed for total and active chlorophyll-*a* and total suspended solids concentrations. These field standards are related to sensor readings via regression procedures. An example of the calibration curve derived for chlorophyll-*a* is shown in Figure 5-1. Note that each cruise has its own calibration curve.

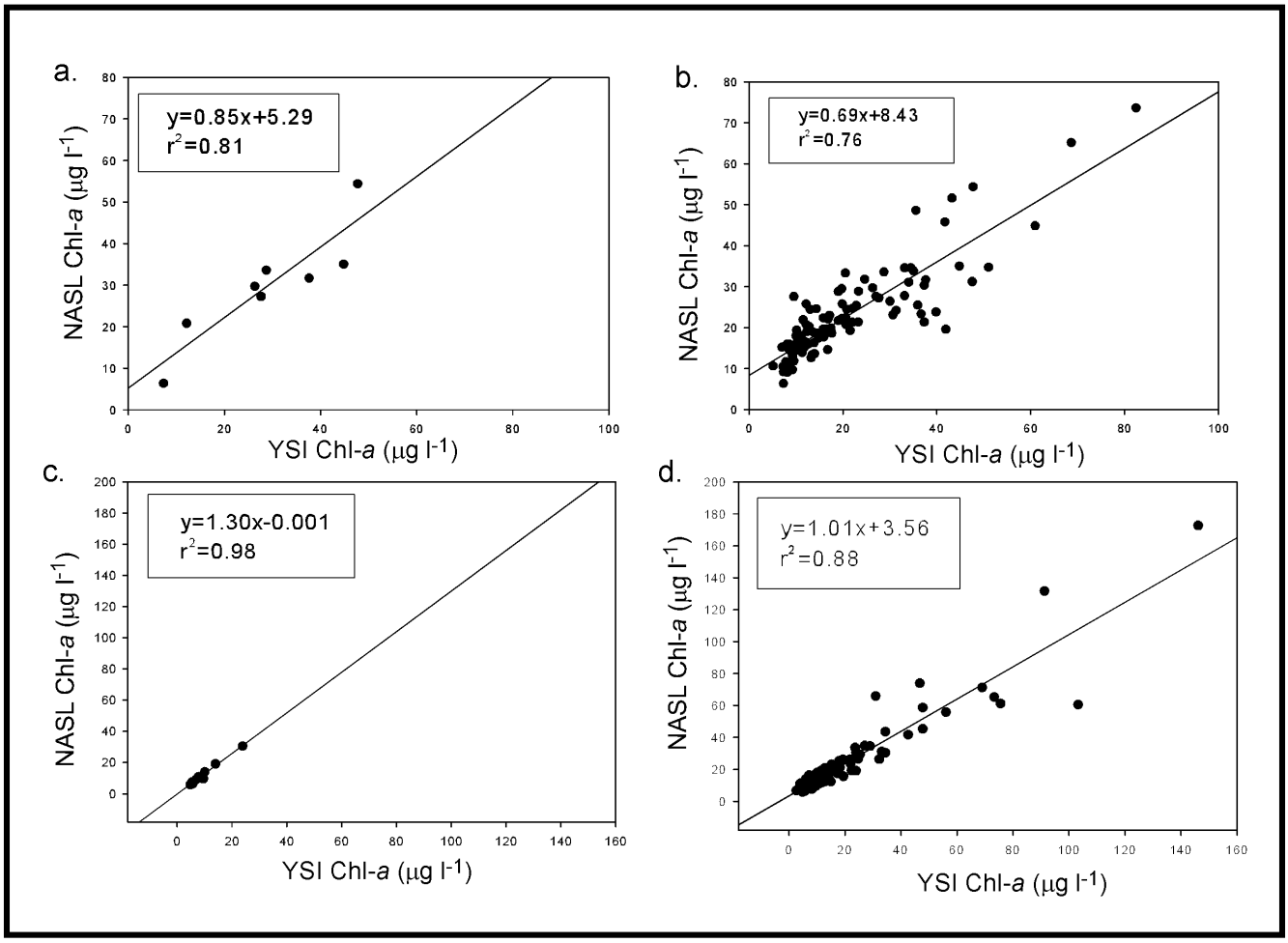

Figure 5-1. Chlorophyll-*a* calibration curves for:
a. Magothy River, May 22, 2002
b. Magothy River 2002 (13 cruises)
c. Severn River, May 23, 2002 and
d. Severn River 2002 (14 cruises)

5.3 Recording of Field Data

All field data is recorded on specially prepared field data sheets that are included as Appendix A. The initials of the person recording the data are recorded on each data sheet. The raw data sheets are reviewed for possible missing data values due to sample collection problems prior to data entry. These sheets are filed in the laboratory. A cruise log book is also kept.

5.3.1 General Information Related to Data Sets

5.3.1.1 Naming Conventions

Data files are given unique names, which are a combination of an alpha code reflecting the name of the data set, the type of data set and a numeric descriptor that indicates the number of the cruise.

5.3.1.2 Incorporation of Error Codes in Data Tables

In order to keep a record of problems experienced while collecting data a one or two letter alpha code (Appendix D) is entered in the data table that describes the problems associated with questionable parameter values. Valid entries from the Sediment Data Management Plan (EPA, 1989) are used and where necessary additional codes which are related to the EPC have been added.

5.3.1.3 Data Tables QA/QC Control

Data recorded by instruments in the field are entered directly onto specially prepared data sheets. A blank data set for each data set is included in Appendix C. Data from samples analyzed by NASL are returned in written format. Data are keyed into Microsoft Excel using the specific data set layout developed during the continuing effort begun in August 1989 to standardize all EPC data files. Hard copies of the files are manually checked for errors. Data files are corrected, a second printout produced which is re-verified by a different staff member.

5.3.1.4 Spatially Intensive Water Quality Mapping - Raw Data Sets

The data are electronically transferred from the datalogger to a computer at the end of each day of sampling. The data are stored as an ASCII text file. This file is retained indefinitely as the original record of the data collection. Due to the enormous quantity of data no hard copy will be submitted.

5.3.2 Submission of Data Files

Files are submitted as ASCII files. Wherever possible the EPC abbreviations for variables are used. Additional information regarding the format of the data and details of variable labels, file structure and data and sampling anomalies are to be submitted as a metadata file to fulfill the requirements of the EPA Chesapeake Bay Liaison Office (EPA/CBLO).

5.3.2.1 Spatially Intensive Water Quality Mapping - Processing of Data

Very little post-processing is required before the data can be used. However, there are two kinds of problems that occur occasionally: misread positioning information and erroneous values caused by electronic noise. Both problems can usually be detected easily by visually scanning the data, by calculating summary statistics, or by calculating the difference between successive observations. Post-calibrations of the transmissometer, fluorometer and dissolved oxygen sensors are applied to the Excel data sets.

5.4 Description of Individual Data Sets

5.4.1 SAV Habitat Evaluation Data Sets

Data files are given unique names that are a combination of an alpha code reflecting the type of data set and a numeric descriptor indicating the year (yyyy) of the SAV samples were collected.

WATER QUALITY MEASUREMENTS (Filename: **WCNDyyyy,** Appendix C-2.1) contains temperature, salinity and dissolved oxygen data measured at 0.5 meters below the water surface.

WATER COLUMN LIGHT ATTENUATION MEASUREMENTS (Filename: **WCLTyyyy**, Appendix C-2.2) reports photosynthetically active radiation (PAR) measurements.
*****NOTE: This data table will be changed to accommodate the new on board measurement of Kd values for each station.***

WATER COLUMN NUTRIENT MEASUREMENTS (Filename: **WCNTyyyy**, Appendix C-2.3) contains dissolved nutrients, and chlorophyll-*a* (active and total) concentrations in the surface waters at each station.

EPIPHYTE BIOMASS MEASUREMENTS (Filename: **ECHLyyyy**, Appendix C-2.4) contains epiphyte chlorophyll-*a* concentrations (total and active), (Filename: Raw data file - **EVLRyyyy**, Appendix C-2.5; Mean data file - **EVLMyyyy**, Appendix C-2.6) contains total epiphyte dry weight and percent inorganic fraction measurements.

5.4.2 Spatially Intensive Water Quality Mapping Data Sets

Two data sets contain the continuous surface water quality measurements, however **please note** that due to the large quantity of data no hard copy of the data is submitted, but a single parameter sheet is found in Appendix B. QA/QC checks identify missing data that are documented in these data sets using the appropriate code.

Filename **DFslCDyyyy** (where sl = sample designation, e.g. PX = Patuxent River), the field calibration data set contains: date, time, latitude, longitude, total depth; concurrent YSI instrument readings for temperature, salinity, dissolved oxygen (DO), fluorescence, and transmissometer value; secchi depth, PAR (for the calculation of Kd) as well as laboratory analyses for active chlorophyll-*a*, total chlorophyll-*a*, phaeophytin, total suspended solids and total volatile solids.

Filename **DFslMDmmddyy** (where sl = sample designation, e.g. PX = Patuxent River), the screened data set contains: date, time, latitude, longitude for each record of water temperature, salinity (ppt), dissolved oxygen ($\mu g\ l^{-1}$), fluorescence ($\mu g\ l^{-1}$) and

transmissometer values (NTU). In addition, includes estimated active chlorophyll-*a*, total chlorophyll-*a* and light attenuation coefficient based on the raw instrument readings and the field calibrations.

5.5 Preparation and Checking of Data Tables

Epiphyte data from samples analyzed by NASL are returned in written format. Data are keyed into a spreadsheet format from the original data sheets developed for the program and hard copies are printed and checked against the original data by a separate staff member. Data files also contain the last revision date for each file.

5.6 Measurement of Kd

Down welling light penetrating the water column (Photosynthetically Available Radiation, or PAR) is measured underwater at several depths to calculate the light attenuation coefficient, Kd. Simultaneous deck and submersed PAR measurements are taken to account for variability in incident surface irradiance due to changing atmospheric conditions (*i.e.* cloud cover). The equipment employed includes an LI-192SA flat cosine Underwater Quantum Sensor, an LI-190SA air (deck) reference sensor, and an LI-1400 Data Logger.

5.6.1 Kd Calculations

Light measurements are taken simultaneously of both surface (I_0) and submarine PAR intensity (I_{z+n}). Submarine PAR is measured at the surface (0.1 meters), and successive intervals thereafter (I_{z+1}, I_{z+2},…I_{z+n}).

Each deck reading is normalized to an arbitrary deck reading of 2000 mmol m^{-2} sec^{-1} and the simultaneously recorded submarine reading is multiplied by this ratio to correct the individual submersed readings of each profile for any difference in solar insolation intensity during the profile. The attenuation coefficient (Kd) is then calculated as:

$$K_{z,z+n} = \frac{\ln(I_{z+n}/I_{z+(n-1)})}{\Delta Z}$$

where:

$K_{z,z+n}$ = attenuation coefficient (m-1) over the depth interval z+n, z+(n-1)
I_{z+n} = normalized PAR intensity at depth z+n (mmol m-2s-1), i.e. deeper value
$I_{z+(n-1)}$ = normalized PAR intensity z+(n-1) depth (mmol m-2s-1)
ΔZ = difference in depth (m) between z+n, z+(n-1)

The natural log of each normalized PAR value is plotted on the x-axis vs. depth. The slope of the line times (-1.0) is Kd.

6. PROJECT QUALITY ASSURANCE/QUALITY CONTROL

For information related to parameter accuracy and precision please refer to Table 2-2.

6.1 Audit

The NASL at the Chesapeake Biological Laboratory provides nutrient analyses to University, State and Federal agencies. As part of the laboratory's QA/QC program, NASL participates in cross calibration exercises with other institutions and agencies whenever possible. Refer to D'Elia *et al*. (1997) for specific details but some examples include:

- Particulate carbon and nitrogen cross calibration with Woods Hole Oceanographic Institution and Horn Point Environmental Laboratory.

- International Council for the Exploration of the Sea (ICES) inorganic nutrient round-robin communication. The fourth international inter-comparison report was published in 1991 (Kirkwood, Aminot and Perttilä, 1991).

- Comparisons of dissolved nutrient analyses conducted at Horn Point Environmental Laboratory, Bigelow Laboratory, the University of Delaware and the University of New Hampshire.
- Quarterly cross calibration exercises with Virginia Institute of Marine Science (VIMS) and Old Dominion University (ODU). The most recent inter-comparison (November 1995) confirmed all parameters routinely analyzed by these laboratories as part of the Chesapeake Bay Monitoring Program. Samples from various saltiness and nutrient regimes were analyzed under this exercise.

- Environmental Protection Agency (EPA) unknown audits for various nutrients have been conducted.

- EPA audits of known nutrients were analyzed using samples in different salinity water while looking for possible matrix effects.

NASL has analyzed National Institute of Standards and Technology (NIST) and National Research Board of Canada reference materials, primarily estuarine sediment, as a check for their particulate and sediment carbon, nitrogen and phosphorus methods.

As part of the Chesapeake Bay Mainstem Monitoring Program, the laboratory analyzes approximately ten percent of the total sample load for QA/QC checks. These samples include laboratory duplicates and spike analyses. Two audits are completed each year, the most recent was completed in winter 2002 (February).

Specific EPC procedures include inorganic nitrogen (ammonium [NH_4^+], nitrite [NO_2^-], nitrite plus nitrate [$NO_2^- + NO_3^-$] and dissolved inorganic phosphorus [DIP or PO_4^{-3}] for which a standard curve usually comprising five concentrations encompassing the expected range for that particular sample set, are analyzed at the beginning of each new run. A standard, which is treated as a sample, is analyzed at least every 20 samples. Baseline corrections are determined either manually or automatically, depending on the instrument providing the analysis. Data needed to calculate concentrations are recorded along with the sample concentration in laboratory notebooks, a carbon copy of which is provided to the EPC group. This procedure is also carried out for other parameters performed by the laboratory in support for the EPC effort. Precision and limits of detection for the variables are included in D'Elia *et al.* (1997) and included as part of the sampling procedure in Appendix A.

6.2 Sample Custody

Upon arrival at NASL, samples are counted, observed for potential problems (melting, broken containers, *etc*.) and placed in a freezer until analysis. Sample information and date of arrival are recorded on a log sheet.

6.3 Instrument Maintenance

Analytical instruments are maintained on a regular basis and records are kept of hours of operation, scheduled maintenance, pump tube changes, *etc*. A critical spare parts inventory is maintained for each instrument. Instrument down-time is minimized by troubleshooting instrument problems telephonically with manufacturers and service representatives. Spare parts can be received within 24 hours via next-day air service.

7. DATA ANALYSIS AND REPORTING

7.1 Analysis of existing data

The PI has analyzed and reported water quality information of the Chesapeake Bay and related tributaries including the Potomac, Patuxent, Choptank and Susquehanna Rivers since 1985. Two data sets, the Vertical Flux Array (VFX) data set and the Sediment Oxygen and Nutrient Exchanges (SONE) data set are now complete. Yearly technical reports have been submitted continuously since 1984, published results and numerous presentations have been made at various program review and professional meetings. Various smaller studies with particular reference to distinct ecologically important aspects of the EPC program have been completed, data collected, analyzed and the results included in the final report. The PI has also suggested new areas where additional data could improve the quality of the EPC study, *e.g.* the inclusion of the spatially intensive resolution bottom water chlorophyll-*a* mapping to improve the spatial dynamics of the study.

All data files are delivered as flat ASCII files.

7.2 Reports

Two reports will be delivered.

- ***Level I: Data and Progress Report*** will contain data tables for activities conducted between January and June, 2003. An electronic copy of the text (Microsoft Word 97) and a read-only PDF version of the report are to be submitted.

*****NOTE: Water column nutrient concentration data collected by EPC as part of the continuous water quality monitoring and spatially intensive monitoring programs in 2003 will be sent directly to Maryland DNR from Nutrient and Analytical Services Laboratory (NASL) as part of the standard monitoring protocols and will not be the responsibility of the Ecosystems Processes Component (EPC).***

- The second report is the comprehensive ***Level I: Interpretive Report*** that will be delivered as a draft, and will then be updated to reflect the corrections required by the contracting officer. This report will include graphics and statistical analyses of these data with particular emphasis on the major objectives of DNR monitoring program. Comparisons will be made with relevant scientific literature. An electronic copy of the text of this report Microsoft Word will be submitted, in addition to a read-only PDF version of the report. Graphics files or individual data used to construct the graphics will not be supplied.

Additional deliverables:

- An updated QAPP document for fiscal year 2004 will be submitted. Both hard copy and electronic copy of the final QAPP will be provided.

- Monthly reports documenting progress made with field-work and in data management will be submitted.

All reports are submitted by Dr. Walter R. Boynton, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038 to Mr. Bruce Michael, Maryland Department of Natural Resources, Resource Assessment Administration, Tide Water Ecosystems Assessment Division**,** Tawes State Office Building, D-2, 580 Taylor Avenue, Annapolis, MD 20401.

8. PROJECT ORGANIZATION AND RESPONSIBILITIES

This section lists the individuals responsible for the major aspects of the EPC of Maryland's Chesapeake Bay Water Quality Monitoring Program.

The collection and preparation of samples, plus data entry and management will be completed at Chesapeake Biological Laboratory under the direction of Professor Walter Raymond Boynton (PI). All correspondence regarding this project should be addressed to: Dr. Walter R. Boynton, Chesapeake Biological Laboratory, University of Maryland, Center for Environmental Science, P.O. Box 38, Solomons, MD 20688-0038. All sediment and water quality analyses are performed by Nutrient Analytical Services Laboratory (NASL) at the Chesapeake Biological Laboratory.

Principal Investigator: Professor Walter Boynton

RESPONSIBILITIES: The principal investigator (PI), Dr. Walter Boynton, will supervise all activities associated with this project. This includes field work, data management and report writing. He will be responsible for all stages of the analysis of samples, resolving problems that may arise, and assure the satisfactory completion of the study. He is responsible for data review and oversight and submission of data. The PI will review the results of the analyses and approve the quality assurance/quality control protocols to insure the validity of the results. The PI will administer the financial and technical requirements of the project and be responsible for preparing the data and progress report and the final report to be submitted at the end of the project. He will also meet, at regular time intervals, with the other members of staff to discuss and review their responsibilities in relation to the project. The PI will respond to questions by the contracting agencies regarding the completion of different stages of the project and the reports that have to be submitted as part of the deliverables outlined in the project contract.

Field Program Coordinator: Robert M. Stankelis,
Senior Faculty Research Assistant (1997-Present)

RESPONSIBILITIES: Mr. Robert M. Stankelis oversees the field program, is responsible for portions of the data analysis and report preparation. He reports to the principal investigator.

Field Program Supervisor: Eva K.M. Bailey
Faculty Research Assistant (2002-Present)

RESPONSIBILITIES: Ms. Eva K. M. Bailey assists in field program management and is responsible for data analysis, report preparation and presentation. She reports to the principal investigator.

Field Program Supervisor: Paul W. Smail
Faculty Research Assistant (2002 - Present)

RESPONSIBILITIES: Mr. Paul W. Smail assists in data collection, data analysis, and instrument maintenance.

Seasonal Field Program Assistant: Maria A.C. Ceballos
Seasonal Field Assistant (2002)

RESPONSIBILITIES: Ms. Maria A.C. Ceballos assists in data collection, data analysis, and instrument maintenance.

Data Manager: Dr. Frances Mary Rohland
Associate Research Scientist (1989-Present)

RESPONSIBILITIES: Dr. Frances M. Rohland is responsible for preparing monthly reports, reviewing data sheets and some data entry procedures, producing and documenting the final data sets and for the final report manuscript. She reports to the principal investigator.
She is the current webmaster working on the development of the Ecosystems Ecology web page: http://cblcbos1.cbl.umces.edu/sone/

9. REFERENCES

Aspila, I., H. Agemian, and A.S.Y. Chau. 1976. A semi-automated method for the determination of inorganic, organic and total phosphate in sediments. Analyst 101:187-197.

Boynton, W.R. and W.M. Kemp. 1985. Nutrient regeneration and oxygen consumption by sediments along an estuarine salinity gradient. Mar. Ecol. Prog. Ser. 23:45-55.

Boynton, W.R., W.M. Kemp and C.W. Keefe. 1982. A comparative analysis of nutrients and other factors influencing estuarine phytoplankton production, p. 69-90. In: V.S. Kennedy, [Ed.], Estuarine Comparisons, Academic Press, NY.

Boynton, W.R., W.M. Kemp, J.M. Barnes, F.M. Rohland, L.L. Matteson, L.L. Magdeburger, J.D. Hagy III, J.M. Frank, B.F. Sweeney, M.M. Weir and R.M. Stankelis. 1997. Ecosystem Processes Component Level 1 Interpretive Report No. 14. Chesapeake Biological Laboratory (CBL), University of Maryland System Center for Environmental and Estuarine Studies, Solomons, MD 20688-0038. Ref No. [UMCEES]CBL 97-009a.

Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir. 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, J.D. Hagy, and J.M. Frank. 1999. Ecosystem Processes Component Level 1 Interpretive Report No. 16. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 99-0070a.

Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, J.D. Hagy, and J.M. Frank. 2000. Ecosystem Processes Component Level 1 Interpretive Report No. 17. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 00-0174.

Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, J.M. Frank and J.M. Lawrence. 2001. Ecosystem Processes Component Level 1 Interpretive Report No. 18. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 01-0088.

Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, J.M. Frank and J.M. Lawrence. 2002. Ecosystem Processes Component Level 1 Interpretive Report No. 19. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 02-0152a.

D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman. 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038.

Environmental Protection Agency (EPA). 1979. Methods for Chemical Analysis of Water and Wastes. USEPA-6000/4-79-020. Environmental Monitoring and Support Laboratory, Cincinnati, OH.

Environmental Protection Agency (EPA). 1983. Chesapeake Bay: A Framework for Action. Chesapeake Bay Program: Annapolis, MD. 186 p.

Environmental Protection Agency (EPA). 1989. Sediment data management plan. Chesapeake Bay Program. CBP/TRS 29/89.

Kemp, W.M. and W.R. Boynton. 1980. Influence of biological and physical factors on dissolved oxygen dynamics in an estuarine system: implications for measurement of community metabolism. Estuar. Coast. Mar. Sci. 11:407-431.

Kemp, W.M. and W.R. Boynton. 1981. External and internal factors regulating metabolic rates of an estuarine benthic community. Oecologia 51:19-27.

Kirkwood, D., A. Aminot and M. Perttilä. 1991. International Council for the Exploration of the Sea (ICES) Report on the Results of the 4th Intercomparison Exercise for Nutrients in Sea Water. No 174. ISSN 1017-6195.

Magnien R.E. *et al.* 1987. Monitoring for management actions. First Biennial Report. The Maryland Office of Environmental Programs, Chesapeake Bay, Water Quality Monitoring Program, Baltimore, MD.

Michael, B., B. Ebersole, M. Trice and C. Trumbauer. 2003. Quality Assurance Project for the Maryland Department of Natural Resources Chesapeake Bay Shallow Water Quality Monitoring Program. Tidewater Ecosystem Assessment, Maryland Department of Natural Resources, Annapolis, MD.

Mihursky, J.A. and W.R. Boynton. 1978. A review of the Patuxent Estuary Data Base. Final Report to Maryland Department of Natural Resources Power Plant Siting Program. Ref. No. [UMCES] CBL 78-157.

Parsons, T.R., Y. Maita and C.M. Lalli. 1984. Determination of chlorophylls and total carotenoids: Spectrophotometric method. pp. 101 - 112 *in* Parsons, T.R., Y. Maita and C.M. Lalli. A manual of chemical and biological methods for seawater analysis. Pergamon Press, Oxford.

Strickland, J.D.H. and T.R. Parsons. 1972. A practical handbook of seawater analysis. Fish. Res. Bd. Can. Bull. 167 (second edition).

Weiss, R.F. 1970. The solubility of nitrogen, oxygen and argon in water and seawater. Deep Sea Research 17:721- 735.

APPENDIX A:
EPC PARAMETERS

APPENDIX A: NOTE:

Note that "DNR/EPC ABBREVIATION; ANALYTICAL METHOD NO. AND FIELD METHOD NO." in each of the descriptions of parameters in this section were originally coded following the guidelines outlined in:

Environmental Protection Agency (EPA). 1989. The Sediment Data Management Plan, Chesapeake Bay Program. United States Environmental Protection Agency, CBP/TRS 29/89.

This plan was made available to us when the first data dictionary for the EPC program was compiled in 1990.

At this time we have reviewed and wherever possible we have standardized and used water quality parameter abbreviations, "NEW_METHOD" codes from the CBP Water Quality Database (1984 - present) Data Dictionary (http://www.chesapeakebay.net/data/index.html the online data dictionary at the Chesapeake Information Management System (CIMS) Data Hub http://www.chesapeakebay.net/cims/index.htm), incorporating them into our document. We have not changed sediment or SAV parameters.

A-1. EPC Parameter: Ammonium

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

CBP/ABBREVIATION: ***NH4F***

ANALYTICAL METHOD NO.: NH4FL01

METHOD SUMMARY: The ammonium in a filtered water sample is by the Berthelot Reaction in which a blue-colored compound similar to indophenol forms when a solution of ammonium salt is added to sodium phenoxide, followed by the addition of sodium hypochlorite. The addition of a potassium sodium tartrate and sodium citrate solution prevents precipitation of hydroxides of calcium and magnesium.

INSTRUMENTATION: Technicon TrAAcs-800 Nutrient Analzyer

REFERENCES:

(1) **Technicon Industrial Systems.** 1986. Technicon Industrial Method No 804-86T. Technicon Industrial Systems, Tarrytown, NY 10591.
and: United States Environmental Protection Agency. 1979. Methods of chemical analysis of water and wastes. Off. Res. Devel. Cincinnati, OH. EPA-600/4-79-020.
as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman. 1997.** Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.11.

(2) **Clesceri, L.S., A.E. Greenberg and R.R. Trussell (Editors).** 1989. Standard methods for the examination of water and waste water. Am. Public Health Assoc., Am. Water Works Assoc. and Water Pollution Control Federation. Washington, DC. (Section: 4500-NH3 H. Automated Phenate Method).

REPORTED UNITS: micromolar (μM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0030 μM	May 2002

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
Samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7μm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-2.1. EPC Parameter: Chlorophyll-*a* - Active

CBP/EPC ABBREVIATION: ***CHLA***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
SAV Epiphyte Biomass Measurements (ECHLyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: SDCHAA19 (NEW_METHOD: CHLAL03)

METHOD SUMMARY: The total chlorophyll-*a* sample is acidified and measured flourometrically. Active chlorophyll-*a* is then determined by subtracting the value obtained following acidification from the total chlorophyll-*a* value.

LABORATORY INSTRUMENTATION: Turner Designs Model TD 700

REFERENCES:

(1) **Strickland, J.D.H. and T.R. Parsons.** 1972. A practical handbook of seawater analysis. Bull. 167 (Second Edition), Fisheries Research Board of Canada, Ottawa, Canada.

(2) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman. 1997.** Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.64

REPORTED UNITS:

Surficial Sediments: milligrams per meter squared (mg m^{-2})
Water: micrograms per liter ($\mu g\ l^{-1}$)
SAV Epiphyte Biomass Measurements: micrograms per strip ($\mu g\ strip^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.60 $\mu g\ l^{-1}$	September 1998 - Present
PRECISION:	N/A	Not available	

FIELD METHOD NO.: PPCHF10

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
Water samples are filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7μm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

(3) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank**. 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

FIELD METHOD NO.: EPIF01

COLLECTION DEVICE:

SAV Epiphyte Biomass Measurements: Mylar® strips (2.5 cm x 51 cm x 0.18mm)

SAMPLE COLLECTION: Mylar® strips are deployed *in-situ* for approximately one week to collect epiphytic material. Chlorophyll-*a* is extracted directly off Mylar® strips using analytical method SDCHAA19.

SAMPLE PRESERVATION: Frozen <-20 C

REFERENCES:

(1) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-2.2. EPC Parameter: Chlorophyll-*a* - Total

EPC ABBREVIATION: ***CHLa TOTAL***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
SAV Epiphyte Biomass Measurements (ECHLyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: SDCHTA18 (NEW_METHOD: CHLAL03)

METHOD SUMMARY: Prior to analysis, the sample is thawed and chlorophyll-*a* extracted overnight in 40 ml of 90% acetone. The sample is read flourometrically.

LABORATORY INSTRUMENTATION: Turner Designs Model TD 700
FIELD INSTRUMENTATION: Yellow Springs Instrument (YSI) 6025 Chlorophyll probe

REFERENCES:

(1) **Strickland, J.D.H. and T.R. Parsons.** 1972. A practical handbook of seawater analysis. Bull. 167 (Second Edition), Fisheries Research Board of Canada, Ottawa, Canada.

(2) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman. 1997.** Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.64

REPORTED UNITS:

Surficial Sediments: milligrams per meter squared (mg m^{-2})
Water: micrograms per liter ($\mu g\ l^{-1}$)
SAV Epiphyte Biomass Measurements: micrograms per strip ($\mu g\ strip^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.51 $\mu g\ l^{-1}$	September 1998 - Present
PRECISION:	N/A	Not available	

FIELD METHOD NO.: PPCHF10

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
Water samples are filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7μm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C
Samples are placed in an ice-filled cooler onboard the research vessel and frozen upon reaching shore.

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

(3) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank**. 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

FIELD METHOD NO.: EPIF01

COLLECTION DEVICE:

SAV Epiphyte Biomass Measurements: Mylar® strips (2.5 cm x 51 cm x 0.18mm)

SAMPLE COLLECTION: Mylar® strips are deployed *in-situ* for approximately one week to collect epiphytic material. Chlorophyll-*a* is extracted directly off Mylar® strips using analytical method SDCHTA18.

SAMPLE PRESERVATION: Frozen <-20 C

REFERENCES:

(1) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological

Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-2.3. EPC Parameter: Chlorophyll (*in situ*)

CBP/EPC ABBREVIATION:

STUDY ELEMENTS: Spatially Intensive Water Quality Mapping (DFslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: TBD

COLLECTION DEVICE:
Yellow Springs Instrument (YSI) 6025 Chlorophyll probe

SAMPLE COLLECTION:
Chlorophyll measurements are made *in-situ* with a probe.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	400 $\mu g\ l^{-1}$	0 $\mu g\ l^{-1}$	1997-Present

REFERENCES:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

FIELD METHOD NO.:

SAMPLE COLLECTION: **Spatially Intensive Water Quality Mapping:**
Water is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 - 12 m^{-1}. The conductivity probes are located in-line and are directly exposed to a continuous flow of ambient water. Conductivity value is transmitted directly to YSI 650 data logger.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	400 $\mu g\ l^{-1}$	0 $\mu g\ l^{-1}$	1997-Present

REFERENCES:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-3. EPC Parameter: Conductivity

CBP/EPC ABBREVIATION: ***COND***

STUDY ELEMENTS: SAV Water Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DFslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: CONDF01

COLLECTION DEVICE:

SAV Water Column Profile: Yellow Springs Instrument (YSI) 6560 Temperature/Conductivity probe

SAMPLE COLLECTION:

Conductivity measurements are made *in-situ* with a probe.

REPORTED UNITS: milliesiemens per centimeter (mS cm^{-1})

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	150 mS cm^{-1}	0.1 mS cm^{-1}	1997-Present

REFERENCES:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

FIELD METHOD NO.: COND06

SAMPLE COLLECTION: **Spatially Intensive Water Quality Mapping:**
Water is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 - 12 m^{-1}. The conductivity probes are located in-line and are directly exposed to a continuous flow of ambient water. Conductivity value is transmitted directly to YSI 650 data logger.

REPORTED UNITS: millisiemens per centimeter (mS cm^{-1})

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	100 mS cm^{-1}	0.1 mS cm^{-1}	June 1999 – Present

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-4. EPC Parameter: Depth - Station

EPC ABBREVIATION: ***STATION DEPTH***

STUDY ELEMENT: SAV Water Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)

FIELD METHOD NO.: SAMDF04

COLLECTION DEVICE:
SAV Water Column Profile: Calibrated depth pole

SAMPLE COLLECTION: The calibrated depth pole is marked off at 0.1 meter intervals which indicates the sample depth.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	3.25 m	0.1 m	June 1997-Present

FIELD METHOD NO.: TOTDF01

COLLECTION DEVICE:
Spatially Intensive Water Quality Mapping: Research vessel fathometer (GARMIN GPS/Sounder 185)

SAMPLE COLLECTION: The electronic signal of the Fathometer is directed to the bottom and the echo from that signal is recorded and reported in units of either feet or meters.

Spatially Intensive Water Quality Mapping: The electronic signal of the fathometer is directed to the bottom and the echo from the signal is recorded. The depth data is transmitted as an ASCII string via the NMEA 0183 v1.5 data bus to a digital port on the datalogger, which records the depth data continuously.

REPORTED UNITS: meters (m)

DETECTION LIMITS: **Spatially Intensive Water Quality Mapping:**

Upper Limit	Lower Limit	Dates Valid
600m	0.5 m	July 2001-Present

REFERENCES:
(1) Research Fleet Operations, UMCES, Box 38, Solomons, MD 20688.
(2) Operations Manual, Garmin GPS/Sounder 185.

A-5. EPC Parameter: Dissolved Organic Carbon

CBP/EPC ABBREVIATION: ***DOC***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: TBD

METHOD SUMMARY: A filtered water sample is treated with hydrochloric acid and sparged with ultra pure carrier grade air to driver off inorganic carbon. High temperature combustion (680°C) on a catalyst bed of platinum-coated alumina balls breaks down organic carbon into carbon dioxide (CO_2). The CO_2 is carried by ultra pure air to non-dispersive infrared detector (NDIR) where CO_2 is detected.

INSTRUMENTATION: Shimaszu TOC-500 total organic carbon analyzer.

REFERENCES:

(1) **Sugimura, T. and Y. Suzuki.** 1988. A high temperature catalytic oxidation method for the determination of non-volatile dissolved organic carbon in seawater by direct injection of a liquid sample. Mar. Chem. 24:105-131.

REPORTED UNITS: milligrams per liter (mg l^{-1})

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.15 mg l^{-1}	2003

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
Samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7μm glass fiber filter pad.
SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-6. EPC Parameter: Dissolved Inorganic Phosphorus*

CBP/EPC ABBREVIATION: ***PO4F***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: PO4FL01

METHOD SUMMARY: A filtered water sample is reacted with ammonium molybdate and antimony potassium tartrate in an acid medium to form an antimony phosphomolybdate complex which is reduced to an intensely blue colored complex by acsorbic acid. The sample is measured colorimetrically at 880 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon Auto-Analyzer II

REFERENCES:

(1) **Technicon Industrial Systems.** 1973. Ortho phosphate in water and seawater. Technicon Industrial Method No. 155-71W/Tentative. Technicon Industrial Systems, Tarrytown, NY 10591. p.6.
and: United States Environmental Protection Agency. 1979. Methods for chemical analysis of water and wastes. Method #365.1. Off. Res. Devel. Cincinnati, OH. EPA-600/4-79-020.
as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.29.

(2) **D'Elia, C.F., P.A. Steudler and N.Corwin. 1977.** Determination of total nitrogen in aqueous samples using persulfate digestion. Limnol. Oceanogr. 22: 760-764.

(3) **Valderrama, J.C.** 1981. The simultaneous analysis of total nitrogen and total phosphorus in natural waters. Mar. Chem. 10:109-122.

REPORTED UNITS: micromolar (μM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Date Valid
	N/A	0.0007 μM	May 2002

***NOTE: Water column dissolved inorganic phosphorus values are adjusted using a small correction value:**

(Dissolved Inorganic Phosphorus - (salinity x 0.000816))

REFERENCE:

(1) **Froelich, P.N. and M.E.Q. Pilson.** 1978. Systematic absorbance errors with Technicon Auto Analyzer II Colorimeters. Water Research 12:599-603.

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:

Samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-7. EPC Parameter: Dissolved Oxygen

CBP/EPC ABBREVIATION: ***DO***

STUDY ELEMENTS: SAV Water Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DfslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: DOF01

COLLECTION DEVICE:

SAV Water Column Profile: Rapid Pulse - Clarke type, polarographic, Yellow Springs Instrument (YSI) 6562 DO Probe

SAMPLE COLLECTION:
DO measurements are made *in-situ.*

An electrical current, proportional to the partial pressure of dissolved oxygen in the sample, is recorded and converted to units of milligrams per liter.

REPORTED UNITS: milligrams per liter (mg l^{-1})

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	20 mg l^{-1}	0.3 mg l^{-1}	1997-Present

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

FIELD METHOD: DOF08

COLLECTION DEVICE:
Spatially Intensive Water Quality Mapping and Continuous Water Quality Monitoring:
Rapid Pulse - Clarke type, polarographic, Yellow Springs Instrument (YSI) 6562 DO Probe

SAMPLE COLLECTION: An electrical current, proportional to the partial pressure of dissolved oxygen in the water, is recorded and converted internally to units of milligrams per liter. The water sample is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 - 12 m^{-1}. The dissolved oxygen probe is located in-line and are directly exposed to a continuous flow of ambient water. Dissolved oxygen information is transmitted directly to YSI 6562 data logger.

REPORTED UNITS: milligrams per liter (mg l^{-1})

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	20 mg l^{-1}	0.3 mg l^{-1}	1997 - Present

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-8. EPC Parameter: Fluorescence

EPC Abbreviation: ***FLUOR***

STUDY ELEMENT: Spatially Intensive Water Quality Mapping (DFslMDmmddyy; and DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: FLURF01

COLLECTION DEVICE: Yellow Springs Instrument (YSI) 6025 Chlorophyll Probe

SAMPLE COLLECTION:
Blue excitation light (wavelength=455 nm) is directed onto a continuous flow of water. This excitation energy source is adsorbed by chlorophyll-a and re-emitted as red light (wavelength=685 nm). This red light is detected by a photodiode and the signal is transmitted directly to the data logger. The water sample is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 - 12 m^{-1}.

REPORTED UNITS: %FS (Full scale)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	100%	0%	May 2001 - present

RESOLUTION: 0.1%

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-9. EPC Parameter: Nitrite

CBP/EPC ABBREVIATION: ***NO2F***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: NO2FL01

METHOD SUMMARY: Nitrite in a filtered water sample is determined by diazotizing with sulfanilamide and coupling with N-(1-napthyl)-ethylenediamine dihydrochloride to form a reddish purple azo dye which is then measured colorimetrically at 520 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon TrAAcs-800 Nutrient Analyzer

REFERENCES:

(1) **Technicon Industrial System.** 1987. Technicon Industrial Method No. 818-87T. Technicon Industrial Systems, Tarrytown, NY 10591. p.4. as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.14.

REPORTED UNITS: micromolar (μM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0003 μM	May 2002

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
Samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-10. EPC Parameter: Nitrite+Nitrate

CBP/EPC ABBREVIATION: ***NO23F***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: NO23FL01

METHOD SUMMARY: Filtered samples are passed through a granulated copper cadmium column to reduce nitrate to nitrite. The nitrite (originally present plus reduced nitrate) is then determined by diazotizing with sulfanilamide and coupling with N-(1-napthyl)-ethylenediamine dihydrochloride to form a reddish purple azo dye which is then measured colorimetrically using the Auto-Analyzer II. Nitrate concentration is obtained by subtracting the corresponding nitrite value from NO2 + NO3 concentration.

INSTRUMENTATION: Technicon Auto Analyzer II

REFERENCES:

(1) **Technicon Industrial System.** 1977. Nitrate and nitrite in water and seawater. Technicon Industrial Method No. 158-71W/A Tentative. Technicon Industrial Systems, Tarrytown, NY 10591. p.4.
and: United States Environmental Protection Agency. 1979. Method No. 353.2 *in* Methods of chemical analysis of water and wastes. United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio. Report No. EPA-600/4-79-020. March 1979. 460pp.
as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.17.

REPORTED UNITS: micromolar (µM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0007 µM	May 2002

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE :

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
Both samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7mm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

A-11. EPC Parameter: Particulate Carbon

CBP/EPC ABBREVIATION: ***PC***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslMDmmddyy; DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: PCA08

METHOD SUMMARY: Prior to analysis the pads in the aluminium foil are placed in a drying oven and dried overnight at 45C. Combustion of the sample occurs in pure oxygen under static conditions in excess of oxygen at about 950C. Detection of carbon is by thermal conductivity using a Perkin-Elmer 240-XA Elemental Analyzer.

INSTRUMENTATION: Technicon Auto Analyzer II

REFERENCES:

(1) **Control Equipment Corporaion.** 1986. Operating Manual for Model 240-XA Elemental Analyzer. Lowell, MA.

(2) **D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman.** 1988. Nutrient Analytical Stervices Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.49.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	6.32 $\mu g\ l^{-1}$	Oct 1987-Present

FIELD METHOD NO.: PCNF09

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION: A water sample of surface (between zero and one meter of surface) and bottom (within one meter of bottom) is collected using a submersible pump (see above). A known volume of water is filtered using a Gelman filter and a precombusted (Muffled) 2.5 cm

diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminium foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, precombusted (550 C for one hour), 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen < -20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD. [UMCES]CBL Ref. No. 89-050. p.49.

A-12. EPC Parameter: Particulate Nitrogen

CBP/EPC ABBREVIATION: ***PN***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslMDmmddyy; DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: PNA09

METHOD SUMMARY: Prior to analysis the pads in the aluminium foil are placed in a drying oven and dried overnight at 45C. Combustion of the sample occurs in pure oxygen under static conditions in excess of oxygen at about 950C. Detection of carbon is by thermal conductivity using a Perkin-Elmer 240-XA Elemental Analyzer.

INSTRUMENTATION: Technicon Auto Analyzer II

REFERENCES:

(1) Control Equipment Corporaion. 1986. Operating Manual for Model 240-XA Elemental Analyzer. Lowell, MA.

(2) D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman. 1988. Nutrient Analytical Stervices Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.49.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	10.5 $\mu g\ l^{-1}$	Oct 1987-Present

FIELD METHOD NO.: PCNF09

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION: A water sample of surface (between zero and one meter of surface) and bottom (within one meter of bottom) is collected using a submersible pump (see above). A known volume of water is filtered using a Gelman filter and a precombusted (Muffled) 2.5 cm

diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminium foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, precombusted (550 C for one hour), 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen < -20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD. [UMCES]CBL Ref. No. 89-050. p.49.

A-13. EPC Parameter: Particulate Phosphorus

CBP/EPC ABBREVIATION: ***PP***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: PPA10

METHOD SUMMARY: The sample is dried at 50 overnight, muffled at 550 C for 1.5 hours and cooled. Phosphorus is extracted using 1N HCl and the "phosphomolybdenum blue" complex read colorimetrically at 880 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon Auto Analyzer II

REFERENCES:

(1) **Aspila, I., H. Agemian and A.S.Y. Chau.** 1976. A semi-automated method for the determination if inorganic, organic and total phosphate in sediments. Analyst. 101:187-197.

(2) **D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman.** 1988. Nutrient Analytical Stervices Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.49.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	1.2 $\mu g\ l^{-1}$	Oct 1987-Present

FIELD METHOD NO.: PPCHF10

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION: A water sample of surface (between zero and one meter of surface) and bottom (within one meter of bottom) is collected using a submersible pump (see above). A known volume of water is filtered using a Gelman filter and a precombusted (Muffled) 2.5 cm

diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminium foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, precombusted (550 C for one hour), 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen < -20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD. [UMCES]CBL Ref. No. 89-050. p.49.

A-14. EPC Parameter: Particulate Inorganic Phosphorus

CBP/EPC ABBREVIATION: ***PIP***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: PPA10

METHOD SUMMARY: The sample is dried at 50 overnight. Phosphorus is extracted using 1N HCl and the "phosphomolybdenum blue" complex read colorimetrically at 880 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon Auto Analyzer II

REFERENCES:

(1) **Aspila, I., H. Agemian and A.S.Y. Chau.** 1976. A semi-automated method for the determination if inorganic, organic and total phosphate in sediments. Analyst. 101:187-197.

(2) **D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman.** 1988. Nutrient Analytical Stervices Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.49.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	1.2 $\mu g\ l^{-1}$	Oct 1987-Present

FIELD METHOD NO.: PPCHF10

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
A known volume of water is filtered using a Gelman filter and a precombusted (Muffled) 2.5 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminium foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, precombusted (550 C for one hour), 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen < -20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD. [UMCES]CBL Ref. No. 89-050. p.49.

A-15. EPC Parameter: pH

CBP/EPC ABBREVIATION: ***PH***

STUDY ELEMENTS: SAV Watyer Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DFslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: TBD

COLLECTION DEVICE:

SAV Water Column Profile: Yellow Springs Instrument (YSI) 6566 pH probe

SAMPLE COLLECTION:

pH measurements are made *in-situ* with a probe.

REPORTED UNITS:

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	14	0	2003

REFERENCES:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

FIELD METHOD NO.:

SAMPLE COLLECTION: **Spatially Intensive Water Quality Mapping:**
Water is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 - 12 m^{-1}. The conductivity probes are located in-line and are directly exposed to a continuous flow of ambient water. Conductivity value is transmitted directly to YSI 650 data logger.

REPORTED UNITS:

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	14	0	2003

REFERENCE:

(2) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-16. EPC Parameter: Phaeophytin

CBP/EPC ABBREVIATION: ***PHEO***

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)

ANALYTICAL METHOD NO.: PHEOL01

METHOD SUMMARY: Prior to analysis, the sample is thawed and chlorophyll-a extracted overnight in 40 ml of 90% acetone. The sample is read flourometrically. Two drops of 1N Hydrochloric Acid are added to the sample and it is read flourometrically once more.

LABORATORY INSTRUMENTATION: Turner Designs Model TD 700

REFERENCES:

(1) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman. 1997.** Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.64 Revised February 2002.

REPORTED UNITS: micrograms per liter ($\mu g\ l^{-1}$)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.48 $\mu g\ l^{-1}$	September 1998 - Present
PRECISION:	N/A	Not available	

FIELD METHOD NO.: PPCHF10

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DFslMDmmddyy)

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle noting the exact time of collection (to the second) from the Global Positioning System. This facilitates later matching of chlorophyll-*a* measurements with concurrent fluorescence readings from the instrument.

SAMPLE COLLECTION:
Water samples are filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7μm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C
Samples are placed in an ice-filled cooler onboard the research vessel and frozen upon reaching shore.

REFERENCES:

(1) Garber, J.H., W.R. Boynton and W.M. Kemp. 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir. 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

(3) Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank. 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

A-17. EPC Parameter: Photosynthetically Active Radiation

CBP/EPC ABBREVIATION: ***EPAR_D, EPAR_S, SDEPTH***

STUDY ELEMENTS: SAV Water Column Light Attenuation Measurements (WCLTyyyy)
Spatially Intensive Water Quality Mapping (DFslMDmmddyy; DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: TBD

METHOD SUMMARY:

SAV Water Column Light Attenuation Measurements: The LI-192SA sensor is lowered over board and measurements taken *in-situ* at several discrete water depths. Simultaneous light flux readings are measured with the LI-190SA deck sensor.

COLLECTION DEVICE: Li-Cor Li-192SA underwater quantum sensor, LI-190SA deck reference quantum sensor, LI-1400 data logger.

SAMPLE COLLECTION:

SAV Water Column Light Attenuation Measurements: The Li-192SA is lowered over board and measurements taken *in-situ* at several discrete water depths. Simultaneous light flux readings are measured with the LI-190SA deck sensor to be used as a correction factor

.

REPORTED UNITS: µM m^{-2} sec^{-1} or µE (microEisteins)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0 µM m^{-2} sec^{-1}	1997 - present

REFERENCES:

(1) **LI-COR Inc.** 1990. LI-COR Underwater Radiation Sensors, Type SA Instruction Manual, Publication No. 8609-57. LI-COR, Inc., 4421 Superior Street, P.O. Box 4425, Lincoln, NE 68504.

A-18. EPC Parameter: Salinity

CBP/EPC ABBREVIATION: ***SALIN/SALINITY***

STUDY ELEMENTS: SAV Water Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DfslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: SALINITYF04

COLLECTION DEVICE: Yellow Springs Instrument (YSI) Model probe 6560 Temperature/Conductivity probe.

SAMPLE COLLECTION: Salinity is determined automatically by the probe, from Sonde conductivity and temperature readings according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (1989).

REPORTED UNITS: practical salinity units (psu)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	400 psu	± 0.5 psu	July 1984 - 1998
	70 psu	0 psu	1999 - Present

REFERENCES:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-19. EPC Parameter: Secchi Depth

CBP/EPC ABBREVIATION: ***SECCHI***

STUDY ELEMENTS: SAV Water Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: SECCIF01

COLLECTION DEVICE: Secchi Disk

SAMPLE COLLECTION: A secchi disk measuring 25.5 cm* diameter is used. The upper surface is divided into four equal quadrants and are colored so that the two quadrants opposite each other are black and the intervening ones are white.

Readings with the secchi disk are made *in-situ* without the aid of sunglasses. The secchi disk is lowered into the water and the depth at which it is no longer visible is recorded.

For use in spatially intensive water quality measurements, the secchi depth reading is taken near the stern of the vessel and the time at which the reading is taken is noted (to the second) from the Global Positioning System. This facilitates later matching of secchi depth readings with transmissometer data.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.1 m	July 1984-Present

REFERENCES:

(1) **Tyler, John**. 1968. The secchi disk. Limnol. Oceanogr. 13(1): 1-6.

**** Note: VIMS, ODU and DNR use a 20 cm Secchi disk.***

A-20. EPC Parameter: Silicate

CBP/EPC ABBREVIATION: ***SI***

STUDY ELEMENTS: Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICALFIELD METHOD NO.: SIOH4A07

METHOD SUMMARY: This reaction is based on the reduction of silicomolybdate in acidic solution to "molybdenum blue" by ascorbic acid. Oxalic acid is added to eliminate interference from phosphates. The silicomolybdate complex is measured colorimetrically at 660nm using the Auto-Analyzer II.

REFERENCES:

(1) **Technicon Industrial Systems.** 1977. Silicates in water and seawater. Technicon Industrial Method No. 186-72W/B. Technicon Industrial Systems, Terrytown, NY. 10591. p2.

as modified by: D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman. 1988. Nutrient Analytical Services Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.21.

REPORTED UNITS: micromolar (µM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.21µM	May 1985-Present

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:

The water sample is filtered using a Gelman filter and a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected.

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.21µM	May 1985-Present

A-21. EPC Parameter: Temperature

CBP/EPC ABBREVIATION: ***WTEMP***

STUDY ELEMENTS: SAV Water Column Profile (WCNDyyyy)
Spatially Intensive Water Quality Mapping (DfslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: WTEMPF01

COLLECTION DEVICE:
SAV Water Column Profile: Yellow Springs Instrument (YSI) 6560 Temperature/Conductivity probe

SAMPLE COLLECTION:
Temperature measurements are made *in-situ*. 0.5 meters below surface.

REPORTED UNITS: centigrade (C)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	45 C	0.1 C	July 1997-Present

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

FIELD METHOD NO.: TEMPF05

STUDY ELEMENT: Spatially Intensive Water Quality Mapping (DFslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy.DAT)

COLLECTION DEVICE: YSI 6560 Conductivity/Temperature Probe

SAMPLE COLLECTION: Water is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 - 12 m^{-1}. The temperature probe is located in-line and is directly exposed to a continuous flow of ambient water. Water temperature information is transmitted directly to 650 data logger.

REPORTED UNITS: degrees centigrade (C)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	>50 C	0.1 C	June 2001-Present

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-22. EPC Parameter: Total Dissolved Nitrogen

CBP/EPC ABBREVIATION: ***TDN***

STUDY ELEMENT: Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: TDNA04

METHOD SUMMARY: This method uses the persulfate oxidation technique for nitrogen where under alkaline conditions, nitrate is the sole N product. Filtered samples are passed through a granulated copper cadmium column to reduce nitrate to nitrite. The nitrite (originally present plus nitrate) is then determined by diazotizing with sulfanilamide and coupling with N-(1-napthyl)-ethylenediamine dihydrochloride to form a reddish purple azo dye which is then measured colormetrically using the Auto-Analyzer II.

REFERENCES:

(1) **D'Elia, C.F., P.A. Steudler and N. Corwin.** 1977. Determination of total nitrogen in aqueous samples using persulfate digestion. Limnol. Oceanogr. 22:760-764.

(2) **Technicon Industrial System.** 1977. Nitrate and nitrite in water and seawater. Technicon Indistrial Method No. 158-71W/A Tentative. Technicon Industrial Syustems, Tarrytown, NY 19591. p.4.

and: United States Environmental Protection Agency. 1979. Methods of chemical analysis of water and wastes. Method #353.2. Off. Res. Devel. Cioncinnati, OH. EPA-600/4-79-020.

as modified by: **D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman.** 1988. Nutrient Analytical Services Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.29.

REPORTED UNITS: micromolar (µM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	1.4 µM	May 1985-Present

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
A water sample is filtered using a Gelman filter and a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in four Auto-Analyzer (AA) vials, which are triple rinsed with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen < -20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD. [UMCES]CBL Ref. No. 89-050. p.25.

A-23. EPC Parameter: Total Dissolved Phosphorus

CBP/EPC ABBREVIATION: ***TDP***

STUDY ELEMENT: Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: TDPA06

METHOD SUMMARY: This method uses the persulfate oxidation technique for phosphorus where under alkaline conditions, phosphorus is the sole P product. A filtered water sample is reacted with ammonium molybdate and antimony potassium tartrate in an acid medium to form an antimony-phosphomolybdate complex which is reduced to an intensely blue colored complex by ascorbic acid. The sample is measured colormetrically at 880 nm using the Auto-Analyzer II.

REFERENCES:

(1) **Menzel, D.W. and N. Corwin.** 1965. The measurement of total phosphorus in seawater based on the liberation of organically bound fractions by persulfate oxidation. Limnol. Oceanogr. 10:280-282.

(2) **United States Environmental Protection Agency.** 1979. Methods for chemical analysis of water and wastes. Method #365.3. Off. Res. Devel. Cincinnati, OH. EPA-600/4-79-020.
as modified by: **D'Elia, C.F., N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmerman.** 1988. Nutrient Analytical Services Laboratory Standard Operating Procedures. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.29.

REPORTED UNITS: micromolar (µM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.03 µM	Oct 1987-Present

FIELD METHOD NO.: DISNF08

COLLECTION DEVICE:

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
A water sample is filtered using a Gelman filter and a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in four Auto-Analyzer (AA) vials, which are triple rinsed with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen < -20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD. [UMCES]CBL Ref. No. 89-050. p.25.

A-24. EPC Parameter: Total Suspended Solids

CBP/EPC ABBREVIATION: ***TSS***

STUDY ELEMENT: Spatially Intensive Water Quality Mapping (DFslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: TSSL01

COLLECTION DEVICE:

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle noting the exact time of collection (to the second) from the Global Positioning System. This facilitates later matching of total suspended solids measurements with concurrent transmissometer readings from the mapping instrument.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:
A known volume of water sample is filtered in the laboratory on a pre-weighed 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and placed on ice.

SAMPLE PRESERVATION: Sample bottles are placed in an ice-filled cooler on the research vessel and filtered samples prepared in the laboratory are frozen and stored until analyzed.

REFERENCES:

(1) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank**. 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

A-25. EPC Parameter: Turbidity

CBP/EPC Abbreviation: ***TURB_NTU***

STUDY ELEMENT: Spatially Intensive Water Quality Mapping (DFslMDmmddyy)
Continuous Water Quality Monitoring (slcmmddyy)

FIELD METHOD NO.: TURB_NTUL01

COLLECTION DEVICE:
Yellow Springs Instrument (YSI) 6136 Turbidity Probe

SAMPLE COLLECTION:
A filtered, single wavelength light source is passed through a 10-cm column of continuously flowing seawater. A photodiode sensor converts returns a voltage proportional to the amount of transmitted light. This voltage is sensed and recorded by the datalogger. Voltages are converted nephalometric turbidity units (NTU) via a calibration curve established in the laboratory. The water sample is pumped from approximately 50 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a nominal flow rate of at least 8 – 12 m^{-1}.

REPORTED UNITS: nephalometric turbidity units (NTU).

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	200 NTU	0.1 NTU	June 2001-Present

REFERENCE:

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** 2002. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

A-26. EPC Parameter: Volatile Suspended Solids

CBP ABBREVIATION: ***VSS***

EPC ABBREVIATION: ***VOLSOL***

STUDY ELEMENTS: SAV Epiphyte Biomass Measurement (EVLRyyyy)
SAV Water Column Nutrients (WCNTyyyy)
Spatially Intensive Water Quality Mapping (DfslCDyyyy)
Continuous Water Quality Monitoring (slcmmddyy)

ANALYTICAL METHOD NO.: TSSA13

METHOD SUMMARY: A known volume of water or water that also contains epiphytic material is filtered through pre-weighed filter pads. Filter pads are dried overnight at 103-105 C and weighed. Filter pads are then combusted at 550 C for 90 minutes and then re-weighed. Volatile weight is determined by subtraction.

REFERENCES:

(1) **Clesceri, L.S., A.E. Greenberg and R.R. Trussell (Editors).** 1989. Standard methods for the examination of water and water water. Method 2540.E. Am. Public Health Assoc., Washington, DC. 1268p.

REPORTED UNITS: milligrams (mg l^{-1})

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	1.98 mg l^{-1}	
PRECISION:	N/A	Not determined	

FIELD METHOD NO.: TVSF11

STUDY ELEMENT: SAV Epiphyte Biomass Measurement (EVLRmmyy)

COLLECTION DEVICE: Mylar® strip

SAMPLE COLLECTION: Epiphytic material is removed from Mylar® strips and filtered onto the preweighed glass fiber filter.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, dried, preweighed, 0.7 µm glass fiber filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

SAMPLE PRESERVATION: Frozen <-20 C

REFERENCES:

(1) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

FIELD METHOD NO.: TVSF12

COLLECTION DEVICE:

SAV Water Column Nutrients: Hand held boat pump taken at 0.5 meters below the surface.

Spatially Intensive Water Quality Mapping: Water discharged from a short tube located immediately after the discharge from the DATAFLOW instrument is collected in a sample bottle.

Continuous Water Quality Monitoring: A grab sample is taken at 1 meter below the surface with a Niskin bottle.

SAMPLE COLLECTION:

The water sample is filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen <-20 C

REFERENCES:

(1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.

(2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

APPENDIX B:
SAMPLE DATA SHEETS

B-1. DATAFLOW V Cruise Plan: Patuxent River R/V Pisces

4/28/2003 – 4/29/2003

Area of Operations: Patuxent River from Drum Point, upriver to south end of Jug Bay.

Scientists: *P.W. Smail, E. M. Bailey*

Objectives: Map water column properties relevant to light attenuation within the study area. Map any differences in water quality parameters that occur along inshore-offshore transects and depth gradients throughout the study region.

Cruise Schedule:

Monday:
4/28/2003

0630 Prepare for departure.

0700 Depart CBL boat basin at Solomons, MD, begin mapping in lower Patuxent River (6 calibration stations) between Drum Point and Benedict. Fifteen minutes spent at each calibration station.

1330 Return to Solomons, refuel R/V Pisces and return to CBL boat basin.

1400-1500 Filter water samples and download data from loggers.

Tuesday:
4/29/2003

0630 Prepare for departure.

0700 Depart CBL boat basin at Solomons, MD; cruise to Benedict.

0745 Begin mapping in upper Patuxent River (6 calibration stations) between Benedict and south end of Jug bay. Fifteen minutes spent at each calibration station.

1200 Discontinue mapping and cruise downriver to Solomons.

1245 Return to Solomons, refuel R/V Pisces and return to CBL boat basin.

1315-1415 Filter water samples and download data from loggers.

B-2. SAV HABITAT EVALUATION: Water Column and SAV Field Data Sheet*

Light sampling methodology currently under review for 2003 by organizations participating in Dataflow/Continuous Monitoring. Changes to data tables will be included in September, 2004 QAPP update.

Near Shore Water Quality Evaluation

Technician		**Light Attenuation*** Depth 1:*	**PAR***	**PAR***
Station:				
Date:		Depth 2:*		
Time:		Depth 3:*		
Latitude:		Secchi:		
Longitude:		**Dataflow/SAV Data** Temperature:		
Station Conditions				
Depth:		Salinity:		
Air Temp:		Conductivity:		
Cloud Cover (~%):		DO %:		
Wind (diection/~speed)		DO:		
Wave Condition:		Transmissometer:		
Filtering Data		Chlorophyll:		
CHLA volume filtered:		Flourometer:		
TVS pad numbers:		**Comments**		
TVS volume filtered:				

E-TVS	Pad #	Diluted Vol	Filtered Vol.

Technician		**Light Attenuation*** Depth 1:*	**PAR***	**PAR***
Station:				
Date:		Depth 2:*		
Time:		Depth 3:*		
Latitude:		Secchi:		
Longitude:		**Dataflow/SAV Data** Temperature:		
Station Conditions				
Depth:		Salinity:		
Air Temp:		Conductivity:		
Cloud Cover (~%):		DO %:		
Wind (direction/~speed)		DO:		
Wave Condition:		Transmissometer:		
Filtering Data		Chlorophyll:		
CHLA volume filtered:		Flourometer:		
TVS pad numbers:		**Comments**		
TVS volume filtered:				

E-TVS	Pad #	Diluted Vol	Filtered Vol.

B-3. Spatially Intensive Water Quality Measurements: Field Calibration Data Set: File DFslCDyyyy

TABLE E-1.1. MAGOTHY AND SEVERN RIVERS CONTINUOUS SURFACE WATER QUALITY MEAUREMENTS
DATAFLOW STATION AND CALIBRATION DATA 2002

VARIABLE	DEFINITION	UNITS
STATION	Calibration Station	
DATE	Sampling Date	YYYYMMDD Year-Month-Day
TIME	Time	hh:min:sec
LATITUDE	Location of calibration station	DD.DDDD Degrees North Latitude decimal degrees
LONGITUDE	Location of calibration station	DD.DDDD Degrees West Latitude decimal degrees
SECCHI DEPTH	Maximum visual depth	meters (m)
DEPTH	Meters	meters (m)
D1*	Depth at first light flux measurement	meters (m)
D2*	Depth at second light flux measurement	
D3*	Depth at third light flux measurement	
Light Flux 1*	PAR1 - photosynthetically active radiation at D1	micromol per meter square per second $\mu M\ m^{-2}\ s^{-1}$
Light Flux 2*	PAR2 - photosynthetically active radiation at D2	micromol per meter square per second $\mu M\ m^{-2}\ s^{-1}$
Light Flux 3*	PAR3 - photosynthetically active radiation at D3	micromol per meter square per second $\mu M\ m^{-2}\ s^{-1}$
Kd1*	Light attenuation calculated between D1 and D2	m^{-1}
Kd2*	Light attenuation calculated between D1 and D2	m^{-1}
Kd3*	Mean Kd calculated from Kd2 and Kd3	m^{-1}
TRANSMISSOMETER†	Transmissometer sensor output	nephalometric turbidity units (NTU)
FLOUROMETER	Flourescence (% full scale)	%FS
CHLOROPHYLL	Calculated from florescence on YSI probe	$\mu g\ l^{-1}$
TSS	Total suspended solids	milligrams per liter (mg l^{-1})
VSS	Volatile suspended solids	milligrams per liter (mg l^{-1})
CHL-T	The total chlorophyll-a of a water sample is acidified and measured fluorometrically.	$\mu g\ l^{-1}$
PHAEOPHYTIN	Readings are taken before and after acidification of ground extract using 2 drops of 1 N HCl to fluorometrically measure phaeophytin.	$\mu g\ l^{-1}$
CHL-A	The total chlorophyll-*a* of a water sample is acidified and measured fluorometrically. Active chlorophyll-*a* is then determined by subtracting the value obtained following acidificiation from the total chlorophyll-*a* value	$\mu g\ l^{-1}$

NOTES:

DATAFLOW parameters reported in 1999 and 2000 remain equivalent, however, several changes in parameter headings were made in 2000 to conform to other portions of the EPC monitoring program. These changes in parameter headings are as follows: Z1, Z2 and Z3 will now be listed under the heading D1, D2, D3, PAR1, PAR2 and PAR3 will now be listed under the heading Light Flux 1, Light Flux 2 and Light Flux 3.

*Light sampling methodology currently under review for 2003 by organizations participating in Dataflow/Continuous Monitoring. Changes will be included in September, 2004 QAPP update.

†Units of transmissometer measurements taken in 1999 and 2000 were in volts (V).

B-4. Spatially Intensive Water Quality Mapping: Calibration Stations.

Approximately 12 stop stations are planned to obtain measurements for field calibrations of the fluorometer and transmissometer. At each stop station we will:

(1) Record time of arrival from GPS.
(2) Record approximate wind speed and direction.
(3) Take Secchi Depth reading, noting exact time of reading from GPS.
(4) Take series of PAR measurements (0.1, 0.5, 1.0 m).
(5) Collect water to filter for chlorophyll-*a* and TSS/VSS analysis in the laboratory.

Equipment Needed:
Light Measurements:

1. Secchi Disk with Cable.
2. Li-Cor Light Meter System:
   LI-192SA, flat cosine Underwater Quantum Sensor
   LI-190SA air (deck) reference sensor
   Data Logger (LI-1400)

Chlorophyll-*a* and TSS/VSS Samples (in laboratory):

1. 2 Glass flasks with electric Vacuum pump, 2 vacuum filtration columns.
2. 60 cc syringe for measuring water.
3. 250 ml graduated cylinder for measuring water for TSS/VSS.
4. 24 pre-weighed filter pads for TSS/VSS
5. 12 filter pads for chlorophyll-*a*.
6. Foil packets for filters.
7. Zip-lock bag for samples that are placed in the freezer.
8. Cooler for water samples.

B-5. Location of Data Flow V Calibration Stations: Patuxent River Stations 2003.

Station	Latitude	Longitude
Magothy River		
PXDF01	38˚ 45.4260’ W	76˚ 41.9580’ N
PXDF02	38˚ 33.6300’ W	76˚ 39.6300’ N
PXDF03	38˚ 41.2200’ W	76˚ 41.7480’ N
PXDF04	38˚ 37.5780’ W	76˚ 40.6080’ N
PXDF05	38˚ 34.8180’ W	76˚ 40.7640’ N
PXDF06	38˚ 31.5180’ W	76˚ 39.8400’ N
PXDF07	38˚ 29.2200’ W	76˚ 40.2180’ N
PXDF08	38˚ 25.5120’ W	76˚ 36.1200’ N
PXDF09	38˚ 20.4540’ W	76˚ 29.3340’ N
PXDF10	38˚ 18.6780’ W	76˚ 25.3080’ N
SV09	38˚ 19.0020’ W	76˚ 27.1560’ N
SV5A	38˚ 24.5280’ W	76˚ 31.3080’ N

B-6. DATAFLOW V Calibration Stations Data Sheet.

Dataflow/Continuous Monitoring					
Technician:	**PAR**	**DECK1**	**WATER1**	**DECK2**	**WATER2**
Station:	Depth 1:				
Date:	Depth 2:				
Time:	Depth 3:				
Latitude:	Depth 4:				
Longitude:	Depth 5:				
Station Conditions	Secchi:				
Depth(m):	**Calibration Data**		DO:		
Air Temp(C):	Temperature:		pH:		
Cloud Cover (~%):	SpecificConduct.:		Transmissometer:		
Wind (direction/~speed):	Salinity:		Chlorophyll:		
Wave Condition (m):	DO%:		Flourometer:		
Filtering Data		**Comments**			
CHLA volume filtered:					
VSS pad numbers:					
VSS volume filtered:					
Dissolved Inorganic/Organic Nutes:					
Silicate:					
TDN/TDP:					
DOC:					
PC/PN:					
PP/PIP:					
Scientist Sign Off:					

B-7. DATAFLOW V Calibration Stations Data (Example).

TABLE E-1.3. MAGOTHY RIVER CONTINUOUS SURFACE WATER MAPPING CALIBRATION DATA 2002
Kd1 calculated from PAR light flux measured at D1 and D2 (or D1 and D2T1)
Kd2 calculated from PAR light flux measured at D2 and D3 (or D2T2 and D3)

FILENAME: DFMRCD2002

Calibration Station	Date	Latitude	Longitude	Secchi (m)	Depth No.	Depth (m)	Light flux µmol/m^2/s	(D1-D2) Kd1	(D2-D3) Kd2	MEAN Kd	Trans (NTU)	Flouro meter (Fs)	Chloro phyll (µg l^{-1})	TSS (mg l^{-1})	TVS (mg l^{-1})	CHL*a*-T (µg l^{-1})	PHAEO (µg l^{-1})	CHL*a*-A (µg l^{-1})
MG01	20020424	39.0562	-76.4357	1.20	D1T1	0.10	997.00				8.90	5.60	31.30	38.40	8.00	24.27	3.31	22.62
					D2T2	0.50	636.80											
					D3T3	1.00	282.90	1.12	1.62	1.37								
MG02	20020424	39.0532	-76.4496	0.90	D1T1	0.10	1037.70				14.20	6.10	34.00	29.50	8.00	31.16	4.15	29.09
					D2T2	0.50	498.40											
					D3T3	1.00	178.53	1.83	2.05	1.94								
MG03	20020424	39.0674	-76.4786	0.65	D1T1	0.10	1171.70				10.70	7.20	39.80	19.50	7.00	23.87	3.80	21.98
					D2T2	0.50	622.40											
					D3T3	SW	SW	1.58	SW	1.58								
MG04	20020424	39.0766	-76.5035	1.10	D1T1	0.10	1201.40				9.00	7.80	41.70	23.50	10.50	45.87	4.44	43.66
					D2T2	0.50	606.30											
					D3T3	1.00	215.30	1.71	2.07	1.89								
MG06	20020424	39.0862	-76.4812	0.90	D1T1	0.10	1359.20				12.90	9.20	51.00	29.50	9.75	34.79	4.30	32.65
					D2T2	0.50	662.00											
					D3T3	1.00	253.60	1.80	1.92	1.86								
MG07	20020424	39.0894	-76.4327	0.70	D1T1	0.10	1337.00				21.20	3.50	19.70	33.00	12.25	29.60	3.36	27.93
					D2T2	0.50	608.10											
					D3T3	1.00	151.26	1.97	2.78	2.38								
MG08	20020424	39.0785	-76.4558	0.95	D1T1	0.10	1395.40				12.00	3.60	19.80	20.00	7.00	25.86	3.37	24.18
					D2T2	0.50	761.00											
					D3T3	1.00	333.50	1.52	1.65	1.58								
MGST	20020424	39.0499	-76.4312	1.00	D1T1	0.10	1419.10				8.60	2.70	15.80	16.75	5.25	22.45	2.91	21.00
							D2T2	0.50	842.60									
							D3T3	1.00	421.00	1.30	1.39	1.35						

B-8. Spatially Intesive Water Quality Measurements.
DATAFLOW V Mapping Data

FILE NAME: DFPXMDmmddyy:

Excel file, the name follows a 12 part descriptor, consisting of an identification of the data set, the location of the data, the data type and date: where DF = DATAFLOW V; PX = Patuxent River, SR = Severn River, MD = Mapping data, mmddyy - date, month, day, year.

MEASUREMENTS:

Date, time, latitude, longitude for each record of water temperature, salinity, dissolved oxygen, total chlorophyll-*a*, fluorescence and transmissometer values. Due to the large quantity of data not hard copy will be provided.

PARAMETERS:

DATE	YYYYMMDD, Year, Month, Day
TIME	HHMMSS, Hours, Minutes, Seconds
LATITUDE	DD.DDDD, Degrees North Latitude
LONGITUDE	DD.DDDD, Degrees West Longitude
TOTAL DEPTH	meters (m)
TEMPERATURE	degrees Celsius (C)
SPECIFIC CONDUCTANCE	millisiemens per centimeter (mS/cm)
SALINITY	parts per thousand (ppt)
DO %	percentage (%)
DO CONC	milligrams per liter (mg l^{-1})
TURBIDITY	nephelometric turbidity units (NTU)
TOTAL CHLOROPHYLL-A	micrograms per liter (µg l^{-1})
FLUORESCENCE	(%FS)

APPENDIX C:
SAMPLE DATA SHEETS (Hardcopy)

Appendix C-1.1:

TABLE F-1.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM
ECOSYSTEM PROCESSES COMPONENT
PATUXENT RIVER AND TANGIER SOUND:
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY
WATER QUALITY CONDITIONS: Temperature, salinity, dissolved oxygen and other characteristics measured at 0.5m below surface at SAV stations

Note: Secchi depth reading noted with + symbol denotes max water column depth, true secchi depth actually greater than value listed

FILENAME: WCND2001
REVISED : 20001103

STATION	DATE	STATION DEPTH (m)	SECCHI DEPTH (m)		TEMP (ºC)	COND (mS)	SAL (ppt)	DO (mg l^{-1})	DO SAT (%)
SIBT	20010515	0.65	0.70	+	19.86	17.52	25.57	10.60	128.60
SIBC	20010515	0.80	0.80	+	20.38	16.32	24.24	12.32	150.10
SMSP	20010515	1.10	1.00	+	18.35	15.45	22.05	8.53	99.50
MRGC	20010515	1.20	1.20		19.26	16.57	23.97	7.64	91.40
JI1G	20010515	1.00	0.95		19.21	17.92	25.75	9.34	112.60
JI2G	20010515	0.95	0.90	+	19.38	18.74	26.94	11.32	137.50
SIBT	20010523	0.90	0.80		20.23	16.53	26.90	8.61	YY
SIBT	20010523	0.90	0.80		20.23	16.53	26.90	8.61	YY
SMSP	20010523	1.20	0.50		20.47	25.51	25.50	8.16	99.20
MRGC	20010523	1.20	0.95		22.21	15.44	25.30	8.70	109.20
JI1G	20010524	0.80	0.80	+	21.26	17.53	28.40	7.11	88.80
JI2G	20010523	1.00	0.90		19.80	17.59	28.46	7.83	95.20
SIBT	20010529	1.00	0.90		20.10	18.33	26.79	7.00	86.00
SIBC	20010529	0.90	0.90	+	20.22	17.94	26.34	7.00	86.00
SMSP	20010529	0.80	YY		20.35	15.97	23.75	7.83	95.10
MRGC	20010529	0.85	0.85	+	21.11	14.84	22.45	8.53	104.10
JI1G	20010529	0.90	0.90	+	21.72	17.90	27.14	7.54	95.50
JI2G	20010529	1.20	0.80		20.28	18.32	26.89	6.76	83.30

Appendix C-1.2:

TABLE F-2.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM
ECOSYSTEM PROCESSES COMPONENT
PATUXENT RIVER AND TANGIER SOUND:
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY
WATER COLUMN LIGHT ATTENUATION MEASUREMENTS:

FILENAME: WCLT2001
REVISED : 20001103

NOTE: This table will be revised and will undergo modification as data are collected using on board equipment to measure Kd.

Appendix C-1.3:

TABLE F3.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM
ECOSYSTEM PROCESSES COMPONENT
PATUXENT RIVER AND TANGIER SOUND:
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY
WATER COLUMN NUTRIENT DATA: Dissolved and particulate nutrients measured at 0.5m below surface at SAV stations
U = uncorrected, no salinity measurement

FILENAME: WCNT2001
REVISED : 20020110

STATION	DATE	NH_4^+ ($\mu mol\ l^{-1}$)	NO_2^- ($\mu mol\ l^{-1}$)	$NO_2^-+NO_3^-$ ($\mu mol\ l^{-1}$)	CORR DIP ($\mu mol\ l^{-1}$)	CHLA-T ($\mu g\ l^{-1}$)	CHLA-A ($\mu g\ l^{-1}$)	TSS ($mg\ l^{-1}$)	VSS ($mg\ l^{-1}$)	PHAEO ($mg\ l^{-1}$)
SIBT	20010515	1.50	0.14	0.92	0.10	3.27	2.78	13.60	1.70	1.00
SIBC	20010515	1.00	0.18	1.62	0.06	2.57	2.32	9.10	1.60	0.50
SMSP	20010515	1.80	0.42	7.62	0.06	5.36	4.84	10.10	2.10	1.05
MRGC	20010515	1.90	0.18	1.01	0.08	4.82	4.10	10.00	2.20	1.48
JI1G	20010515	1.00	0.05	0.64	0.11	7.25	6.46	7.70	1.70	1.60
JI2G	20010515	1.20	0.07	0.37	0.11	4.55	4.01	15.40	2.70	1.09
SIBT	20010523	1.80	0.12	0.81	0.09	4.75	3.57	21.90	3.40	2.42
SIBC	20010523	2.10	0.25	2.60	0.09	7.05	6.13	32.00	4.00	1.85
SMSP	20010523	1.60	0.36	5.34	0.10	9.45	7.98	85.00	6.40	2.98
MRGC	20010523	4.50	35.00	3.56	0.13	7.54	6.30	17.70	3.20	2.52
JI1G	20010524	2.20	1.60	1.04	0.13	3.88	3.28	17.00	2.60	1.21
JI2G	20010523	1.90	0.16	1.14	0.12	8.76	7.15	16.67	3.33	3.27
SIBT	20010529	2.30	0.21	0.71	0.05	7.94	6.86	24.00	2.80	2.20
SIBC	20010529	2.10	0.19	1.58	0.11	3.41	2.94	18.40	2.60	0.97
SMSP	20010529	1.90	0.39	6.05	0.10	11.19	9.94	31.20	3.20	2.54
MRGC	20010529	3.90	0.36	3.36	0.11	7.52	6.32	15.40	2.40	2.44
JI1G	20010529	2.60	0.28	1.93	0.06	0.16	0.00	16.20	2.40	0.00
JI2G	20010529	3.00	0.21	1.58	0.06	7.72	6.47	22.60	3.00	2.54
SV09	20010524	1.20	0.34	9.37	0.1(U)	YY	YY	YY	YY	YY

Appendix C-1.4:

TABLE F-5.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM
ECOSYSTEM PROCESSES COMPONENT
PATUXENT RIVER AND TANGIER SOUND:
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY
EPIPHYTE CHLOROPHYLL-*a* ACCUMULATION: Raw data

FILENAME: ECHL2001
REVISED: 20001106

STATION	DATE	TOTAL TCHL-*a* (µg/strip)	ACTIVE ACHL-*a* (µg/strip)	STRIP AREA (cm^2)	TOTAL TCHL-*a* (µg cm^{-2})	ACTIVE ACHL-*a* (µg cm^{-2})	DAYS *In-situ*	EPIPHYTE ACCUMULATION RATES	
								TCHL-*a* (µg/cm2/day)	ACHL-*a* (µg/cm2/day)
SIBT	20010523	3.12	2.69	64.52	0.0483	0.0417	8	0.0060	0.0052
SIBC	20010523	1.32	1.22	64.52	0.0204	0.0188	8	0.0026	0.0024
SMSP	20010523	1.23	0.70	64.52	0.0191	0.0108	8	0.0024	0.0013
MRGC	20010523	88.30	75.79	64.52	1.3686	1.1746	8	0.1711	0.1468
JI1G	20010523	16.12	13.69	64.52	0.2498	0.2123	8	0.0312	0.0265
JI2G	20010523	6.63	5.77	64.52	0.1027	0.0894	8	0.0128	0.0112
SIBT	20010529	2.58	2.24	64.52	0.0399	0.0347	6	0.0067	0.0058
SIBT	20010529	4.68	4.03	64.52	0.0725	0.0624	6	0.0121	0.0104
SIBT	20010529	1.26	1.01	64.52	0.0195	0.0156	6	0.0032	0.0026
SIBC	20010529	1.34	1.20	64.52	0.0207	0.0186	6	0.0035	0.0031
SIBC	20010529	0.89	0.80	64.52	0.0138	0.0123	6	0.0023	0.0021
SIBC	20010529	0.88	0.79	64.52	0.0137	0.0123	6	0.0023	0.0020
SMSP	20010529	1.43	0.64	64.52	0.0221	0.0099	6	0.0037	0.0016
SMSP	20010529	1.08	0.60	64.52	0.0167	0.0092	6	0.0028	0.0015
SMSP	20010529	1.60	1.35	64.52	0.0248	0.0209	6	0.0041	0.0035
MRGC	20010529	54.41	48.73	64.52	0.8433	0.7553	6	0.1406	0.1259
MRGC	20010529	93.12	80.81	64.52	1.4432	1.2525	6	0.2405	0.2088
JI1G	20010529	1.63	1.48	64.52	0.0253	0.0229	5	0.0051	0.0046
JI1G	20010529	1.46	1.32	64.52	0.0227	0.0204	5	0.0045	0.0041
JI1G	20010529	2.43	2.22	64.52	0.0377	0.0343	5	0.0075	0.0069
JI2G	20010529	4.31	3.86	64.52	0.0668	0.0598	6	0.0111	0.0100
JI2G	20010529	5.74	5.09	64.52	0.0889	0.0788	6	0.0148	0.0131
JI2G	20010529	4.10	3.69	64.52	0.0635	0.0572	6	0.0106	0.0095

Appendix C-1.5:

TABLE F-6.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM
ECOSYSTEM PROCESSES COMPONENT
PATUXENT RIVER SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY
VOLATILE MEASUREMENTS: Inorganic Component of Epiphytes Nutrients: Raw Data

FILENAME: EVLR2001
REVISED : 20001106

Station	Date	Total diluted Volume (ml)	Filtered Volume (ml)	Dilution Factor	Strip Area (cm^2)	Measured TSS ($mg\ l^{-1}$)	Calculated Dry wt/strip (mg/strip)	Dry Wt per area ($mg\ cm^{-2}$)	Measured Inorg wt ($mg\ l^{-1}$)	Calculated Inorg wt/strip (mg/strip)	Inorg wt/strip ($mg\ cm^{-2}$)
SIBT	20010523	250	100	2.50	64.52	31.5	7.9	0.1221	19.5	4.9	0.0756
SIBC	20010523	250	100	2.50	64.52	10.5	2.6	0.0407	4.0	1.0	0.0155
SMSP	20010523	250	125	2.00	64.52	10.0	2.5	0.0387	3.6	0.9	0.0139
MRGC	20010523	500	25	20.00	64.52	370.0	185.0	2.8673	312.0	156.0	2.4179
JI2G	20010523	250	100	2.50	64.52	32.5	8.1	0.1259	21.0	5.2	0.0814
JI1G	20010523	250	100	2.50	64.52	94.0	23.5	0.3642	78.0	19.5	0.3022
SIBT	20010529	250	100	2.50	64.52	31.0	7.8	0.1201	22.0	5.5	0.0852
SIBT	20010529	250	75	3.33	64.52	30.7	7.7	0.1188	17.3	4.3	0.0672
SIBT	20010529	250	75	3.33	64.52	12.7	3.2	0.0491	1.3	0.3	0.0052
SIBC	20010529	250	75	3.33	64.52	7.3	1.8	0.0284	<	<	<
SIBC	20010529	250	100	2.50	64.52	9.0	2.3	0.0349	4.0	1.0	0.0155
SIBC	20010529	250	75	3.33	64.52	8.0	2.0	0.0310	<	<	<
SMSP	20010529	250	100	2.50	64.52	35.5	8.9	0.1376	25.5	6.4	0.0988
SMSP	20010529	250	100	2.50	64.52	32.5	8.1	0.1259	21.5	5.4	0.0833
SMSP	20010529	250	100	2.50	64.52	104.5	26.1	0.4049	86.0	21.5	0.3332
MRGC	20010529	500	50	10.00	64.52	486.0	243.0	3.7663	433.0	216.5	3.3555
MRGC	20010529	500	25	20.00	64.52	314.0	157.0	2.4334	268.0	134.0	2.0769
MRGC	20010529	300	50	6.00	64.52	773.0	231.9	3.5942	674.0	202.2	3.1339
JI1G	20010529	250	75	3.33	64.52	12.7	3.2	0.0491	2.7	0.7	0.0103
JI1G	20010529	250	75	3.33	64.52	6.7	1.7	0.0258	<	<	<
JI1G	20010529	250	75	3.33	64.52	6.7	1.7	0.0258	<	<	<
JI2G	20010529	250	75	3.33	64.52	10.0	2.5	0.0387	0.7	0.2	0.0026
JI2G	20010529	250	75	3.33	64.52	14.7	3.7	0.0568	4.0	1.0	0.0155
JI2G	20010529	250	75	3.33	64.52	9.3	2.3	0.0362	0.0	0.0	0.0000

Appendix C-1.6:

TABLE F-7.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM
ECOSYSTEM PROCESSES COMPONENT
PATUXENT RIVER AND TANGIER SOUND:
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY
EPIPHYTE VOLATILE MEASUREMENTS: Inorganic Component of Epiphyte Nutrients
Mean Data

FILENAME: EVLM2001
REVISED : 20020111

STATION	DATE	DRY WT AREA (mg/cm^2)	INORG WT AREA (mg/cm^2)	% INORG MATERIAL (%)	DAYS *In-situ*	DRY WT AREA DAY (mg/cm^2/day)	INORG WT AREA DAY (mg/cm^2/day)
SIBT	20010523	0.1221	0.0756	38	8	0.0153	0.0094
SIBC	20010523	0.0407	0.0155	62	8	0.0051	0.0019
SMSP	20010523	0.0387	0.0139	64	8	0.0048	0.0017
MRGC	20010523	2.8673	2.4179	16	8	0.3584	0.3022
JI1G	20010524	0.3642	0.3022	17	8	0.0455	0.0378
JI2G	20010523	0.1259	0.0814	35	8	0.0157	0.0102
SIBT	20010529	0.1201	0.0852	29	6	0.0200	0.0142
SIBT	20010529	0.1188	0.0672	43	6	0.0198	0.0112
SIBT	20010529	0.0491	0.0052	89	6	0.0082	0.0009
SIBC	20010529	0.0349	0.0155	56	6	0.0058	0.0026
SIBC	20010529	0.0310	<	<	6	0.0052	<
SIBC	20010529	0.0284	<	<	6	0.0047	<
SMSP	20010529	0.1376	0.0988	28	6	0.0229	0.0165
SMSP	20010529	0.1259	0.0833	34	6	0.0210	0.0139
SMSP	20010529	0.4049	0.3332	18	6	0.0675	0.0555
MRGC	20010529	3.7663	3.3555	11	6	0.6277	0.5593
MRGC	20010529	2.4334	2.0769	15	6	0.4056	0.3461
MRGC	20010529	3.5942	3.1339	13	6	0.5990	0.5223
JI1G	20010529	0.0491	0.0103	79	5	0.0098	0.0021
JI1G	20010529	0.0258	<	<	5	0.0052	<
JI1G	20010529	0.0258	<	<	5	0.0052	<
JI2G	20010529	0.0387	0.0026	93	6	0.0065	0.0004
JI2G	20010529	0.0568	0.0155	73	6	0.0095	0.0026
JI2G	20010529	0.0362	0.0000	100	6	0.0060	0.0000

APPENDIX D
DATA ERROR CODES

Analysis Problem Codes

AGENCY CODE (see note)	ANALYSIS PROBLEM CODE	DESCRIPTION
DNR	A	Laboratory accident
DNR	B	Interference
DNR	C	Mechanical/materials failure
DNR	D	Insufficient sample
DNR	N	Sample Lost
DNR	P	Lost results
DNR	R	Sample contaminated
DNR	S	Sample container broken during analysis
DNR	V	Sample results rejected due to QA/QC criteria
DNR	W	Duplicate results for all parameters
DNR	X	Sample not preserved properly
EPC	AA	Sample thawed when received
DNR	BB	Torn filter paper
EPC	DA	Damaged epiphyte array
EPC	DS	Damaged epiphyte strip
EPC	EE	Foil pouch very wet when received from field, therefore poor replication between pads, mean reported
EPC	EN	Value corrupted by electronic noise
EPC	ES	Position or depth information interpolated due to missing GPS scan
DNR	FF	Poor replication between pads; mean reported
EPC	HD	Particulate and chlorophyll-*a* samples only taken at -1.0 cm of the Eh profile
DNR	HH	Sample not taken
DNR	JJ	Amount filtered not recorded (Calculation could not be done)
EPC	LA	Lost epiphyte array
EPC	LF	All parameters set as missing because instrument flow rate was too low
DNR	LL	Mislabeled
EPC	LS	Lost epiphyte strip
EPC	NI	Data for this variable are considered to be non-interpretable
DNR	NN	Particulates found in filtered sample
EPC	NR	No replicate analyzed for epiphyte strip chlorophyll-*a* concentration
DNR	PP	Assumed sample volume (pouch volume differs from data sheet volume; pouch volume used)
EPC	PW	Excess turbidity caused by research vessel prop wash at shallow stations

Table 4-1. Analysis Problem Codes (Continued)

AGENCY CODE (see note)	ANALYSIS PROBLEM CODE	DESCRIPTION
DNR	QQ	Although value exceeds a theoretically equivalent or greater value (*e.g.*, PO4F>TDP), the excess is within precision of analytical techniques and therefore not statistically significant.
EPC	SD	All sampling at station discontinued for one or more sampling periods
***	SS	Sample contaminated in field
EPC	SW	Shallow water, light flux measured at two points only
EPC	TF	Dissolved oxygen probe failure
EPC	TL	Instrument failure in research laboratory
EPC	TS	Dissolved oxygen probe not stabilized
EPC	TT	Instrument failure on board research vessel
DNR	UU	Analysis discontinued
***	WW	Station was not sampled due to bad weather conditions, research vessel mechanical failure, VFX array lost or failure of state highway bridge to open or close
DNR	XX	Sampling for this variable was not included in the monitoring program at this time or was not monitored during a specific cruise
EPC	YB	No blank measured for MINI-SONE fluxes
EPC	YY	Data not recorded

NOTE:

DNR = Codes used in this study which were identical to those listed in Analytical Problem Codes (APC) table on pages XI-10 and XI-11: Quality Assurance Project Plan. Chemical and Physical Property Component. Appendix XI, June 14, 1999. Revision 5. (**Magnien, R. and B. Michael.** 1999. Quality Assurance Project Plan: Water Quality Monitoring Program — Chemical and Physical Properties Component for the period July 1, 1999 - June 30, 2000. Tidewater Ecosystem Assessment).

CBL = New codes added which are used in the EPC program.

******* = This code is use in both DNR and EPC program but has a different meaning, further clarification is necessary.

APPENDIX E:
CONTINUOUS MONITORING PROCEDURES

From: Michael et al. (2003) QAPP DNR: Shallow Water Quality Monitoring Program, April 1, 2003 – June 30, 2004 (Appendix 1, Appendix 2, Appendix 3, Appendix 4).

E-1. Continuous Monitoring Procedures

Installation:

- To collect seamless continuous data, two instruments are needed for each site. Deploy the first instrument at the site for a week. At the end of the week, replace this instrument with the second instrument. During the next week, post-calibrate and clean the first instrument and prepare it to be deployed the next week.
- Use a 4" diameter PVC pipe to install a site. The length depends on the depth of the selected site.
- Coat the PVC pipe with an effective anti-fouling paint to prevent biological contamination.
- Drill 2" holes down the length of the PVC pipe to allow water to pass through the tube.
- Attach the tube to a wooden 2x4 using two clevis hangers. Then attach the 2x4 to a piling or pier using lag bolts.
- Place a chain through the tube, and lock it with a combination or key lock to prevent theft or vandalism.

Calibration:

- Calibrate each instrument using laboratory quality standards directly prior to each deployment (see Michael *et al.* (2002) Appendix XA. YSI6600cal revised.doc).
- Synchronize the internal clock in the instrument and all watches with the official time. The official time is available by calling 410-844-1212.

Deployment:

- Deploy the instrument at a fixed site at a regular interval, e.g., weekly.
- Leave the instrument that was deployed the prior week in place, while suspending the freshly calibrated instrument at the same depth, right next to the "old" one. Allow both instruments to take at least one simultaneous reading in order to compare the data from the two instruments. This comparison is used during QA/QC process to ensure both instruments were taking accurate measurements
- Use a Hydrolab instrument with a display unit to take an additional simultaneous reading. The real-time display makes it possible to note any sudden fluctuations or trends in the water quality parameters.
- At exact time of sample reading, take a grab sample using a Kemmerer type apparatus.

Sample Processing :

- Grab sample is filtered immediately after it is taken. Sample is filtered according to Chesapeake Bay Program protocol (Appendix 3-2. Continuous Monitoring Filtering methods).
- Processed sample is iced down, and sent to lab for analysis.

Retrieval:

- After both instruments have been allowed to take at least one simultaneous reading, remove the "old" instrument. Brushed out the instrument tube with a Webster-type brush, on the inside and outside. Deploy the fresh instrument in its place. Wrap the "old" instrument in a damp towel and take it back to the lab for post-calibration and cleaning.

Post-calibration/cleaning:

- Post-calibrate each retrieved instrument against laboratory standards to ensure that it was taking accurate measurements (see Appendix XA. YSI6600cal revised.doc)
- After completion of post-calibration, thoroughly clean each instrument and prepare it for re-deployment the following week.

E-2. Continuous Monitoring Filtering Methods

Filter apparatus set up:

- Three port manifold for one Chlorophyll-*a* 47mm magnetic bell and frit
- Two pc/pn 25mm Polysulfone filter funnels with twist-lock coupling bell and frit
- Two 500mL sidearm Erlenmeyer flasks with two 47mm magnetic bell and frit for TSS/PP

One 1000mL sidearm Erlenmeyer flask as a trap in between pump and filtering apparatus

Steps:

- Begin filtering begins within five minutes of collecting the raw water sample.
- Transfer water from the Alpha bottle to a 1000ml Nalgene bottle.
- Shake the bottle prior to filtering to ensure that the sample is mixed and no settling occurs.
- First filter chlorophyll *a*.
- Rinse a clean bell and frit with deionized water to ensure their cleanliness.
- Place a Whatmann 47-mm diameter, GF/F 0.7 µm glass fiber filter pad - on the filter frit with a clean pair of forceps.
- Rinse a graduated cylinder three times with the sample water to prevent contamination, and measure out and filter the raw water.
- Filter enough sample water to produce a solid color on the pad.
- Do not filter chlorophyll *a* for more than five minutes and keep the vacuum pressure below 10 inches of mercury to prevent the cells from lysing.
- When all measured sample water has been drawn through the pad, shut off the vacuum, and write the station, date, and volume of water filtered on a foil.
- Fold the pad in half with the clean pair of forceps, placed in the foil, and put on ice.
- At all times try to minimize the exposure of direct sunlight to the chlorophyll sample.
- Next filter particulate carbon and particulate nitrogen (pc/pn).
- Thoroughly clean bells and frits with deionized water and set up the filter apparatuses.
- Use two pre-combusted 25mm GF/F 0.7 µm filter pads to filter a measured volume through each pad (same volume for each).
- Prior to filtering, agitate the 1000ml Nalgene bottle, and rinse the graduated cylinder three times.
- Filter sample water until there is noticeable color left on each pad.
- Again, write the station, date, and volume on a foil, fold both pads in half, place them in the foil, and store on ice.
- Finally, filter for total suspended solids and particulate phosphorus (TSS/PP).
- This filtering process includes saving filtrate for dissolved organic nitrogen and phosphorus, nitrate-nitrate, nitrate, ammonium, silica, and dissolved organic carbon.
- Use two pre-weighed 47-mm diameter GF/F 0.7-um pads to filter the raw sample water.
- Place the pads on two thoroughly deionized water-rinsed bells and frits.
- Draw an initial 50-ml of sample water though the pads as a rinse.
- After using the rinse to the clean the flask, discard all of the rinse.

- Using a pre-rinsed graduated cylinder, filter a measured volume of sample water through each pad (same volume for both pads).
- Taking the filtrate, rinse four auto-analyzer(AA) vials and caps three times and fill them 7/8 full.
- Next, rinse a glass test tube, cap, and a weighed, self-leveling 10-ml graduated cylinder three times with filtrate, and measure 10-mL carefully into the test tube.
- Fill a 50-mL teflon test tube last.
- Rinse the test tube and cap three times with filtrate and fill them 3/4 full.
- Replace the bells and frits to the flasks and vacuum pressure and both pads undergo three cycles of deionized rinsing to remove as much salinity from the pads as possible.
- Then, write the station, date, and volume (including the first 50-mL of rinse) on a foil, and fold the pads in half and place them in the foil.
- Place all samples (tubes and foil) on ice.
- Upon returning to the field office, place the three foil pouches (Chl-*a*, PC/PN, and TSS/PP), three AA vials (nitrate-nitrate, nitrate, and ammonium), and the glass (dissolved organic nitrogen and phosphorus) and teflon (dissolved organic carbon) tubes for each station in the freezer at -20 °C.
- Place the fourth AA vial from each station in a refrigerator (4 °C) to preserve the silica sample.

E-3. Continuous Monitoring Field Staff QA/QC Procedures
C. Trumbauer
Revised: 9/5/2002

Make sure the parameters are arranged in the following order:

Date, Time, Temp, Sp.Cond, Salinity, DO%, DOconc, pH, Turbidity, Chl, Fluor

Export files from Ecowatch into .CDF format. Keep the same filename and save in the same location. Using Microsoft Excel, open the .CDF file, choosing "comma" when prompted for delimiters. Delete all data that were taken when the meter was not in the water on station. Use the logbooks to determine this time.

Identify any suspicious data by inspecting the original data graph in ***Ecowatch***. Common anomalies include abnormal spikes in chlorophyll and turbidity, abnormal dips in specific conductance, and abnormally high dissolved oxygen readings due to high dissolved oxygen charge. If you use the ***Ecowatch*** graph to identify outliers, you must locate and delete the outliers manually from the data set in MS Excel. Make sure to cut and paste the data into an outlier file. You must save any deleted data in an Excel file, e.g., "MAG006 outliers." Post-calibration and *in-situ* field checks should also be used to identify when probes are reading incorrectly. Any data removed for this reason must also be saved in the outlier file. This information will all be used to prepare a metadata file documenting all anomalous data, whether deleted or not.

Do not be too quick to delete data. Deleting data is necessary to remove obvious outliers from the data set. Strange things can and do occur in Maryland waters, and we do not want to delete an anomaly just because it seems out of place. Anomalies should be identified, but must not be deleted unless there is proper justification. If you feel a period of data is questionable, but should not be excluded, keep it in the data set, but mention it in both the weekly report and the metadata file.

Now save the data file as the same name, replacing the old file. It should appear as "MAG106.cdf" (with the quotes.) Next open the .CDF file in ***Ecowatch*** (for some reason it is better if you exit completely out of Excel). When opening a .CDF file in ***Ecowatch***, it will convert to PC6000 (.DAT) format and prompt to save a filename. Use the same filename as the .CDF file, except add "X" to the end to signify the file has received QA/QC (this will distinguish it from the "raw" .DAT file).

Once you open the new file, inspect the graphs to identify any anomalies that passed through the first QA/QC inspection. If necessary, remove any more outlying data. Once you are satisfied with the file, close ***Ecowatch***.

In addition to a .DAT file, we also need a .CSV file for the database on DNR's website.

The columns must be in the following format:

Date, Time, Temp, Salinity, DO%, DO conc, pH, Turbidity, ChlA

Working from the .CDF file, completely delete the specific conductance field, along with fluorescence and any blank fields. This will leave nine columns. Also, the headers- the first two lines in the spreadsheet serving as column labels- must be deleted. There should be only numbers in this file. Save the file as the same name, the only difference being the .CSV extension.

So, there should be four files when a data set is complete. In our example, these files would be:

MAG006.DAT (Raw data - no editing),

MAG006.CDF (Exported file with travel time and outliers deleted),

MAG006X.DAT (final .DAT file created from CAT006.CDF), and

MAG006.CSV which is basically CAT006.CDF with several columns and the headers deleted).